POWER

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Real Basis of Valuation

SOME years ago the Bureau of Mines established an experimental mine. It did not have money enough to buy the coal land, so it rented it temporarily.

At that time the land was held at $75 per acre.

Year after year the Bureau sought an appropriation for the purchase of the land and year after year the price went up. The last I heard of it, some years ago, it had got to $1,800.

These figures may not be exact, but they were of this order.

When the cost of the coal at the mine is made up in order to justify the prices charged, are the interest and depreciation and depletion figured on the $75 or less that the company originally paid for the land or upon the present appreciated value?

If on the appreciated value, did the company charge itself with the unearned increment as a part of its allowable profits as it accrued?

One economist, John Bauer, for several years connected with the Public Service Commission of the State of New York and for the last five years financial adviser to the Corporation Counsel of the City of New York, has had the temerity in a recent work on "Effective Regulation of Public Utilities," to disallow any appreciation in the value of land so long as the land is in use by the utility, affirming that the original cost only should be used in ascertaining the value for rate-making purposes.

In other words, investors are entitled to a fair or liberal return upon the money that they actually invest.

The universal application of this principle would reduce some rate-making and price-fixing problems to a beautiful simplicity, but it might stunt the growth of some melons.

F. R. Low

The Case for Low-Temperature Carbonization in America Today

By H. W. BROOKS*

SO MUCH has been written and said on the subject of low-temperature carbonization here in America during the last few years that it is worth while to pause and take stock of the situation in its reference to our particular needs. Europe, confronted by different and more pressing problems of mining, military, agricultural and combustion engineering and economics, has been forced to take the lead on research in conservation methods conducive to greater domestic production of oils, gases, ammonium sulphate and smokeless fuels. We, in properly interpreting their results for our maximum benefit, must ask ourselves the following questions:

1. Wherein are our conditions the same and wherein different from those abroad?
2. Why must we seek a new method (low-temperature carbonization) when the old well-established and well-understood high-temperature methods are available?
3. If low-temperature carbonization more satisfactorily solves our conservation problems, what process is to be preferred for our conditions, and why?
4. What are the disadvantages of the new method and how may they be overcome?
5. Is the preferred process as recommended practicable financially as well as technically under the conditions that prevail in this country?

To supply sensible, present-day answers to these questions in view of our situation here is the object of this discussion.

THE author, a consulting fuels and combustion engineer of many years of both practical and research experience in the United States and abroad, was sent to Europe last year by the United States Bureau of Mines, particularly to investigate the present status of European low-temperature carbonization and other fuel-conservation practices.

In applying his observations there to American conditions, he draws conclusions which, while somewhat at variance with those reached by some others, seem to offer more immediate practical possibilities for economically feasible installations in America than many of the proposals of the past. He feels that once the initial economic inertia always confronting any new technical accomplishment is overcome by a money-making demonstration of its feasibility in connection with central-station operation, the future will eventually demonstrate whether semi-coke is more valuable in the form of electricity or as a smokeless domestic fuel. His figures indicate that the utility operator may profit handsomely in the meanwhile and at the same time be prepared to take advantage of the future situation whichever way it may develop.

Commercial-scale installations of low-temperature carbonizing equipment in connection with large power stations are already in operation in America, England and Germany, the coke being burned on chain-grate stokers instead of in pulverized form, which the author advocates as a more efficient method of utilization.—Editor.

American and European Conditions Compared

The majority of commercial-scale installations of low-temperature distillation have been made in Europe. There the better grades of coals such as are now being mined in the United States have been worked out years ago. Most of the British, French and German mines are from two to three times the average depth of the American bituminous mines, resulting in much greater overhead pressures on the coal seams, which in turn produce much higher percentages of fine sizes in mining. For these two reasons the majority of European bituminous coals are washed and sized. Of the total American bituminous production, on the other hand, less than 5 per cent at present is beneficiated. The problem, therefore, of disposition of fine sizes of bituminous in Europe is even more pressing than our well-known American problem of anthracite fines. Furthermore, the central heating system, in which fine coal can be burned if necessary for domestic service, has been relatively little adopted; particularly in England, the old open fire grate still being principally relied upon. Europe, therefore, is of necessity forced either to briquet or waste a large portion of her bituminous fines.

This is not the case in America and will probably not be for the present generation. Briquetting costs money, and as long as American coal operators can dispose of their slack for steam purposes at reasonably profitable prices, it will not pay to further classify and briquet it. The higher per capita power consumption and the greater development of the electrical public utility in America both contribute to greater stability of the slack market here than there.

As for European domestic oil supply, it is well known that the available oil reserves during the war were on occasion dangerously low. European navies and

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merchant shipping were and are now almost entirely dependent upon overseas supplies of fuel oil. In 1920, for example, of the total world oil production of about 97 million tons, the United States produced 64.8 per cent and Mexico 23.3 per cent. Dr. Julian D. Sears, of the United States Geological Survey, estimates[1] that if our consumption of oil could continue without increase at the 1923 rate of 700,000,000 barrels, we would entirely exhaust all known domestic reserves recoverable by present methods within eleven years. Whether or not the geologists' estimate of our total reserve proves too low, "the vital fact remains—our supply is not inexhaustible and when once extracted it is gone forever." What will actually happen, of course, is that domestic consumption will continue to increase as in the past and "the actual result of approaching exhaustion will be declining production and increasing dependence on other sources of petroleum"[1] (with ever increasing transportation or manufacturing costs necessarily added). The present generation has seen this happen in the natural-gas fields. Have we any reason to expect that nature will function differently with respect to oil? Certainly, therefore, advancing oil prices are inevitable.

Present-day inefficiencies in the extraction and use of oil can, must and will be eradicated—always, however, at the expense of increased equipment costs. The much-discussed alternative sources of domestic oil production, oil sand and oil shale, will require enormous investments to develop (of the order of the present total investment in the coal-mining industry). Unlike petroleum, these oils cannot be labor cheap. They thus offer little hope in stemming the tide of advancing prices. Synthetic oils like "synthol" and "methanol" and those produced by Franz Fischer and Bergius in Germany by liquefaction or so-called "hydrogenation" of coal (at pressures of 150 atmospheres or more) lie even farther from the range of present-day price competition with fuel oils. This is still more true of processes proposed for industrial alcohol distillation from vegetable wastes. Owing to the relatively small oil yield of high-temperature distillation processes, the supplying of an appreciable percentage of our national oil resources therefrom would result in an unmarketable production of high-temperature coke. Low-temperature carbonization, on the other hand, can supply not only our oil requirements, but simultaneously our needs for cheap electric power, an efficient smokeless domestic fuel, an enricher for our city gas supply, and a source of supply for ammonium compounds. All these may be produced from cheap bituminous fines.

As the demand for coal for power is greater and vastly more concentrated than that for heating, hence offering greater possibility for large-scale oil production at minimum investment cost through pretreatment, the author has long felt that the immediate future for low-temperature carbonization in America lay in extraction and separate sale of the valuable byproducts and subsequent combustion of the semi-coke (low-temperature coke) in pulverized fuel furnaces at large central power plants. It is felt that the production at present of briquetted fuel here is of lesser importance both economically and from a conservation standpoint, that there is a lesser margin of profit to be expected from it and a less staple and dependable market for it than for electricity.

[1]Sears, J. D.—"Engineers and the American Petroleum Situation," *Mechanical Engineering*, Vol. 47, No. 1, Jan., 1925, p. 10.

In high-temperature coke making for heating service the margin of profit has been found to be highly variable and dependent on many complex conditions generally beyond the operator's control. The domestic demand for coke is highly seasonable. Base-load power plants located at or near mine mouths, practically guaranteed a reasonable margin of profit (as long as they are intelligently managed) through competent public regulation of rates, provide a dependable market for coke in which investment risks are reduced to a minimum and ready capital easily available. It is recognized that the conclusion that electricity rather than smokeless fuel should be the ultimate product of low-temperature carbonization for the present is at variance with the opinion held by many authorities.[2] So far, however, it certainly has not been commercially demonstrated even in Europe and much less in America that

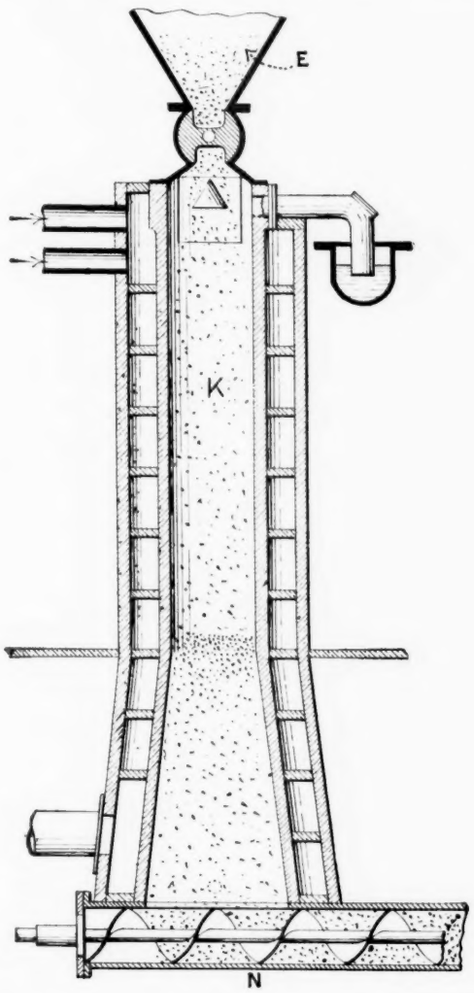

Fig. 1—Vertical shaft retort which carbonizes pulverized coal in suspension

[2]A. C. Fieldner, of the United States Bureau of Mines, apparently agrees with the author's conclusions in this connection. In the report of the Prime Movers Committee, N.E.L.A. (July, 1925) he states (p. 45): "There is also another internally heated process operating . . . in conjunction with boiler furnaces at a large electric power plant. This is the proper field for low-temperature carbonization since it solves the problem of disposition of the semi-coke." Speaking of processes which will be discussed later in this article, he states: "The logical use for the semi-coke from both these processes would be to pulverize it and use it in pulverized-coal furnaces." On page 46 he states; "German engineers were found to be keenly interested . . . in the burning of low-temperature coke in pulverized form, and indeed this appears to us to be the most logical future field for low-temperature distillation."

the additional selling price obtainable for briquetted coke will pay for the additional process and briquetting costs incident to its manufacture. Certainly, the public wants a smokeless domestic fuel. The problem of selling it to the public at a profit, however, still remains substantially unsolved.

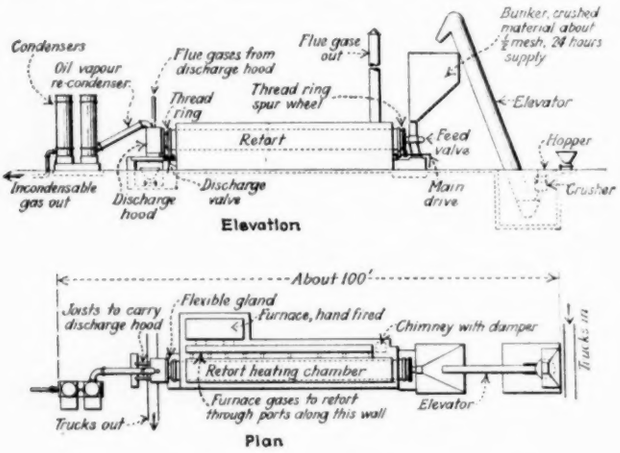

Fig. 2—Fusion retort and auxiliary plant

Low- Versus High-Temperature Carbonization

Dealing specifically with the second question of this discussion, low-temperature processes are likely to be more economical, hence more profitable, than high-temperature processes for pretreatment of bituminous coal for the following reasons:

1. The oils recovered will be in volume two or three times larger and probably eventually will prove of distinctly greater value per gallon than the high-temperature tars, due to inherent chemical and physical differences which will be discussed later.

2. This high oil yield would not glut the market with unmarketable coke to produce a reasonable percentage of our domestic oil requirements as would probably be the case with the low oil yield, high-temperature processes.

3. For power plants low-temperature coke is better adapted to more efficient combustion in pulverized form.

4. Low-temperature coke fulfills the requirements for a smokeless and easily ignitable domestic fuel more desirably than high-temperature coke, when prices justify its sale for such purposes.

5. Low-temperature gases (from externally heated retorts) are richer, hence find a readier (and doubtless eventually a higher-priced) market.

6. Initial investment costs, hence fixed charges, are lower, as are also labor and maintenance costs.

7. The sizes of pipes, tanks, etc., required in handling the volatilized products (from externally heated retorts) will be smaller.

8. Operating at a lower temperature, the former, with properly designed heating surface, will consume less fuel about the retorts in order to maintain the proper carbonizing temperature.

9. Less heat will be lost in the condensing system because of the lower temperature of the various products evolved.

Processes of Low-Temperature Carbonization To Be Preferred

Later in this discussion it will be demonstrated that the present-day value of the primary byproducts alone of low-temperature carbonization when recovered in connection with electric central-station operation will in many cases pay for the entire costs, including fuel, overhead and fixed charges of pretreatment. In such cases, therefore, the value of the semi-coke (70 to 75 per cent of the original coal) used for power generation is clear gain. *In other words, extraction and separate sale of the primary byproducts under these conditions permits the use of an efficient fuel for power which costs nothing.* In view of the foregoing, it is felt that the low-temperature process to be preferred here should be designed primarily with electric central-station operation in view. It should be a continuous process of high throughput, delivering its low-temperature coke in as finely divided a state as possible for subsequent combustion in pulverized form. Producer gas or pulverized fuel should be used in firing the retorts (which should be externally heated) in order to release for sale as an enricher the entire production of high-grade gas.

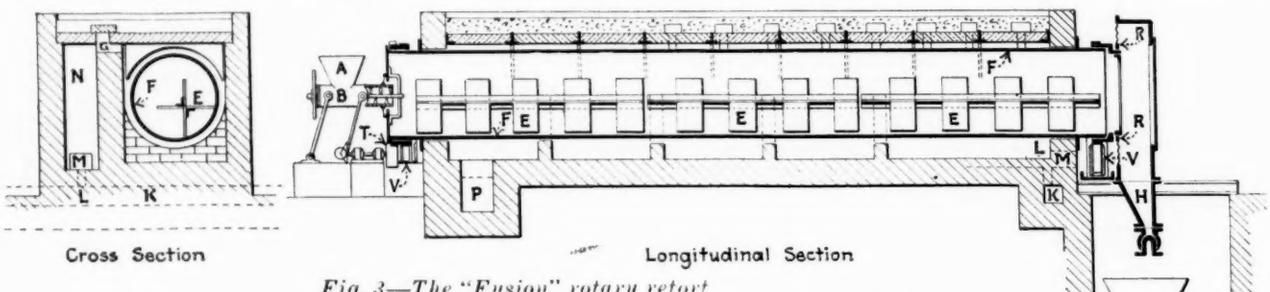

Fig. 3—The "Fusion" rotary retort

A. Raw material hopper.
B. Air-tight automatic feed valve.
E. Breaker or pulverizer.
F. Rotating tube.
G. Ports with dampers for conveying the products of combustion to the heating chamber round the rotating tube F.
H. Hopper with air-tight automatic valve for discharge of spent material.
K. Gas feed conduit.
L. Gas inlet to combustion chamber.
M. Air inlet to combustion chamber.
N. Combustion chamber.
P. Flue to chimney.
R. Gland for making joint between rotating tube and end chamber.
T. Gear for rotating tube.
V. Rollers upon which the tube rotates.

Two processes are available for accomplishing these objectives, the first employing the vertical-shaft retort in which pulverized coal is carbonized in suspension, while the second utilizes a horizontal or inclined cylinder retort, in which lump coal is agitated in contact with heated metallic retort walls. The former type (one design of which is illustrated in Fig. 1) is still in the experimental stage both here and in Europe, though it offers promising results. Many of the same

factors contributing to the present success of combustion of coal in pulverized form would appear to contribute equally to the success of its carbonization in the finely divided state. In this type some form of vertical shaft retort is employed in which there is a large free space *K*. The combustible gas or pulverized fuel used in heating the retort is burned in annular combustion chambers or spaces surrounding the retort in such manner as to provide counter-flow, parallel flow, or any combination thereof, of the heat transfer through the retort walls to give maximum yields and

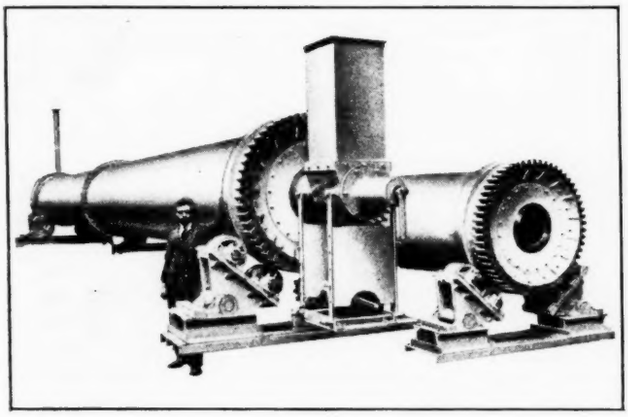

Fig. 4—Two Fusion retort units of 30 tons per day capacity. One has a feed valve in position

operating economies with a given coal. The coal is fed through the hopper *E* in a state of fine subdivision falling through the free space *K*, where it is subjected to the radiant heat and cooling in the lower part, where it collects and is removed by the screw *N*. More elaborate retorts on this principle provide more effective arrangements of heating surface to insure thorough carbonization throughout the falling dust cloud, the illustration having been selected merely on account of its simplicity for purposes of explanation. The fine division of the coal in pulverized form permits rapid and thorough carbonization, permits the effective use of steam to aid oil and ammonium sulphate recovery, minimizes retort, power and heat requirements and delivers the solid fuel residue in a form suitable for subsequent pulverization if necessary with minimum expenditure of power. Judging from the coke made by this process, which the author has seen, it is believed that this could be burned in a furnace of the Fuller "Well Type"[3] just as it comes from the retort without further pulverization. In this furnace, it will be recalled, the flames impinge tangential to a cylinder of fire and a high degree of turbulence is secured.

Processes of the second type employing cylindrical retorts in which the coal is stirred in contact with heated surfaces have been thoroughly tested in large-scale operation in Europe. It is said that not a little of the motor spirits and lubricants used in German automobiles and airplanes during the last year of the war were manufactured from coal by this process as used by Thyssen, Stinnes[4] and others in Germany, some of whose plants are still in operation in the Ruhr. The Fusion Corporation, Ltd., of England, has several of these plants in successful operation and is using the same type of plant for oil-shale distillation in Esthonia.

Unfortunately, cuts are not available of the German externally heated rotary retorts from which best continuous commercial-scale operating results have been obtained. The British "Fusion" rotary type will therefore be described as typical of this class. The general layout of this retort and auxiliary plant is shown in Fig. 2. Fig. 3 shows longitudinal and cross-sections. Fig. 4 shows the assembled unit ready for installation within the refractory heating chamber which surrounds it. The coal enters the rotary retort through an automatic feed valve, passes through the retort tube, where it is carbonized, and is discharged at the other end through an automatic valve to the semi-coke hopper. To prevent sticking of the plastic coal on the retort walls a star-shaped steel breaker, shown in Fig. 3 diagrammatically and in Fig. 5 as actually used (consisting essentially of steel plates radiating from a central spider) extends from end to end in the retort and is free to tumble over as the retort rotates.

Action Similar to Ball Mill

These breakers not only stir the coal and thus constantly expose fresh surfaces to the hot walls, but also give a hammering and chipping action on the sides of the retort, keeping it free from scale. The similarity of action to the cascading of material in a ball or tube mill is apparent. As a result the semi-coke contains a high percentage of fines suitable for combustion in pulverized-fuel furnaces, while the larger pieces can either be repulverized or sold as a domestic fuel. The retort is heated with producer gas or the products

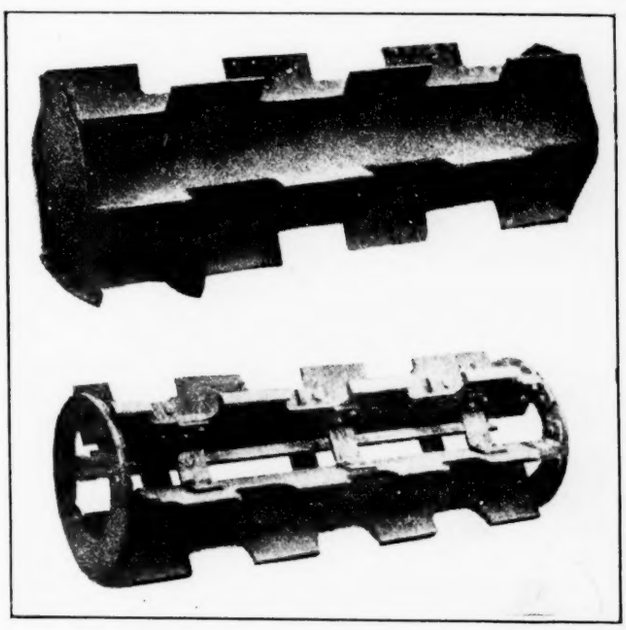

Fig. 5—Two types of breaker carrying steel plates arranged on a spider

of combustion of a hand or mechanically fired grate, the hot gases passing into the combustion chamber located on one side of the retort. Thence they pass to the heating chamber through a number of ports so placed and controllable at the chamber that the temperature of any part of the retort can be controlled.

[3]Described in *Power*, June, 1925.

[4]For descriptions of these processes refer to A. C. Fieldner in the report of the Prime Movers Committee, N.E.L.A. (foreign developments) July 1925, pp. 46 and 47.

In this heating chamber the hot gases encircle the rotating retort spirally to produce counterflow heat transfer, leaving the flue *P* (Fig. 3) in the bottom of the setting at the fuel entering end of the installation,

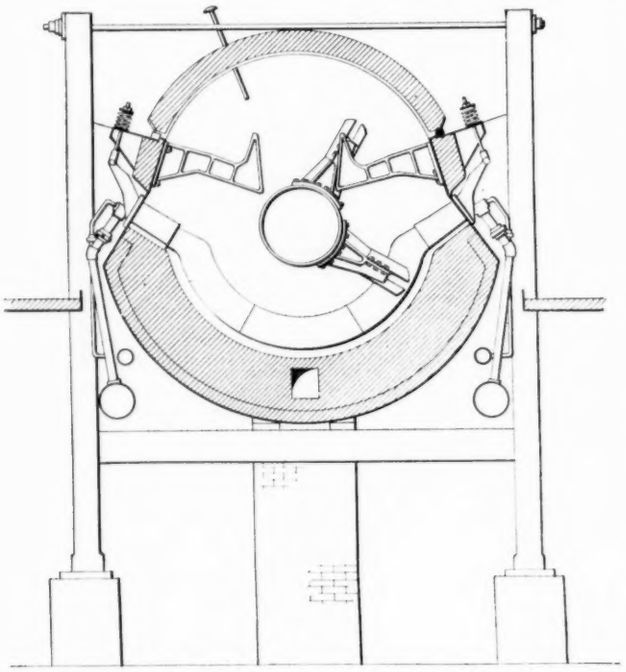

Fig. 6—Section through carbocoal retort

thence passing to the stack. The retort is connected with the usual type of condensing system for collecting oils and tar.

The well-known American Carbocoal retorts illustrated in longitudinal and cross-section in Figs. 6 and 7 differ principally from those previously described in that the retort remains stationary while the motor-driven shaft, carrying arms with coal-agitating paddles moving through the mass of coal and close to the heated surface, oscillates through an arc of about 270 deg. each 30 sec. The lower part of the retort consists of modified V- or U-shaped grooved sections of special heat-resistant iron fitted together with flanges to break the joints. The upper part is a portion of the cylinder, built of light boiler plate covered with Silocel which can be lifted bodily off the lower half for access to the shaft and paddles and the inside of the metal sections. The metal sections forming an efficient fin-type heat transfer surface, are heated from below by burning producer gas. Regenerators may be employed where found desirable.

Some Similar Processes

Other processes of this same general type are the Thomas[5] and the Carbocite process[6] in America, the Freeman,[7] the Fehrson[7] and the Sensible Heat[7] (Nielsen) processes in England and the Fischer and Gluud,[5] the Fellner and Zeigler,[7] and the Raffloer[7] processes in Germany, as well as several others, in which the charge is moved by screw or reciprocating conveyors which probably would not be so well adapted to the production of fine coke that is suitable for combustion in pulverized form.

Conservative primary yields averaged for several hundred tests of many kinds of coal approximate 20 to 30 gal. of crude oil, 2.5 gal. of crude motor spirits, 10 lb. of ammonium sulphate, 3,000 to 4,000 cu.ft. of 800 to 1,000 B.t.u. gas, and 1,500 lb. of coke per net ton of high-volatile bituminous coal processed.[8] The investment cost of the complete plant including primary byproduct recovery apparatus will range from $600 to $1,000 per ton-day capacity (30 to 50 per cent of that of high-temperature oven installations). The coke throughput is reasonably high and bears a high percentage of fines suitable for combustion in pulverized-fuel furnaces such as the Fuller "Well Furnace" with little if any subsequent pulverization. Carbonization and the major share of the pulverization are done simultaneously in one operation. The principal advantage of this general class of methods would appear to be that they have been in satisfactory continuous operation for sufficiently long that no unsuspected operating difficulties may be anticipated.

[*Owing to the length of the article, necessitated by the author's very complete treatment of the subject, space limitations will make it necessary to publish the second part next week. This will take up difficulties encountered and their solution, and the economics of low-temperature carbonization, including calculations as to the probable fixed charges, operating expense and profit as compared with the high-temperature process.*—EDITOR.]

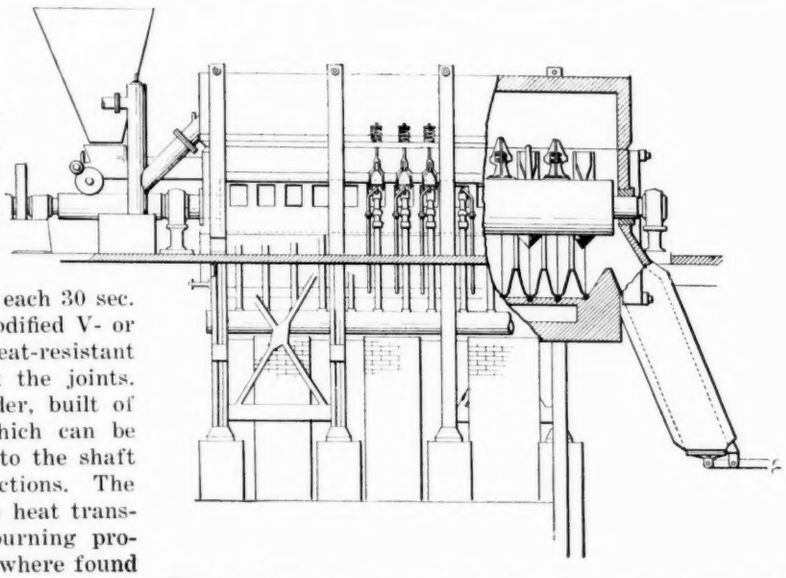

Fig. 7—Side elevation of Carbocoal retort as installed at Fairmont, W. Va., with a capacity of 50 tons per day. Externally heated by gas

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[5]Described in "Practical Coal Carbonization," by A. R. Powell, *Mechanical Engineering*, Vol. 46, No. 7, July, 1924, p. 392.

[6]Described in Penn. "Giant Power Survey" Report, Feb., 1925, p. 381.

[7]Described in "Low Temperature Carbonization," by C. H. Lander and R. F. McKay, pp. 217 to 235.

[8]Computation of thermal efficiency based on above yields shows less than 85 per cent. Measurements made in actual practice by the British Fuel Research Board, Department of Scientific and Industrial Research (1920-21, second edition p. 51, table 5) shows actual test thermal efficiencies ranging from 92.1 to 94.5 per cent. The yields quoted are obviously, therefore, most conservative, all difficulties incident to commercial operating practice having been amply discounted.

Power-Plant Operating Costs*

TYPICAL power-plant operating costs in a variety of industries where steam is required for heating and process. Comparison with purchased service in these instances at prevailing rates is favorable to the industrial power plant.

AS COMPETITION increases in the industrial field, the power-plant department is bound to be scrutinized more carefully, and as fuel advances in price, naturally industrial executives will be seeking further economies in its use. The economic relationship of heat and power is not as well understood in the industrial field as it should be, and as more careful analyses of power-plant costs are made more and better plants will come.

Keeping the plant running and delivering its services, is not all that there is in the business of plant operation. Continuous records must be kept in order that costs can be determined. Improvements and additions can be taken up only in proper order as they are from time to time needed when correct analyses of costs can be made. These costs are of the greatest importance when comparison is made with central-station service.

The following operating data and costs show what is being done in a number of typical plants in different industries:

Hotel Plants

There is probably no industry using a similar amount of power that offers better opportunities for low production costs of heat and power than the modern hotel of fair size. To illustrate the possibilities a comparison is made, giving the cost of coal in one hotel in which a complete power plant is operated and in another house of similar size and character in about the same locality, the cost of coal plus the cost of purchased electric power and light. Both houses have the same number of men in the power-plant department.

TABLE I—COMPARATIVE COAL AND POWER COSTS IN HOTEL PLANTS*

Month	House Purchasing Power Coal Plus Electricity Cost	House Operating Power Plant Coal Cost	Month	House Purchasing Power Coal Plus Electricity Cost	House Operating Power Plant Coal Cost
January	$10,065.39	$7,359.26	September	6,652.71	5,021.90
February	9,596.00	7,287.72	October	7,454.00	5,409.90
March	9,933.02	6,990.76	November	7,813.11	5,206.11
April	7,881.75	5,389.64	December	8,606.80	5,651.68
May	9,083.93	5,392.39			
June	6,999.64	5,278.62	12 Months total	$97,238.04	$69,413.45
July	6,870.19	5,007.35			
August	6,281.50	5,418.12			

*Fixed charges not included.

It will be noticed from Table I that the house purchasing its electricity pays out 40 per cent more money for coal used to produce heat and purchased electricity than the other house pays out for the coal producing all its heat and also its electricity. That much the same difference in operating costs exists in relatively small hotels may be seen in Table II. Here one plant generates all its electricity and furnishes all steam for laundry, kitchen, baths and swimming pool. The other plant buys all its electricity and operates a boiler plant for its various steam needs, including laundry, kitchen, baths, etc. In the table are the figures from actual operating records for one complete year.

Plant A operates boilers for heating and purchases all electricity, while case B supplies all services of heat, light, power and refrigeration from its own power plant.

In case B the building is 25 per cent larger and its plant generates nearly 2½ times as much electricity as case A buys, still B's operating expenses for heat, light, power and steam are 25 per cent less. In case A the power plant is a miserably designed affair and its operating expenses could be reduced materially by spending a little money in making more effective use of exhaust steam and in making ice, instead of purchasing it.

TABLE II—COMPARATIVE ANNUAL RECORDS OF SMALL HOTEL PLANTS

Item	Case A	Case B
Contents of building, cu.ft.	1,000,000	1,250,000
Electricity used, kw.-hr	64,300	149,060
Coal consumed, tons	1,200	2,045
Men employed to operate plant	3	4
Total annual cost of heat, light, power and refrigeration	$21,373	$16,724
Cost per kw.-hr. including heat and steam for all purposes	0.33	0.11
Cost per year per 1,000 cu.ft. of space	21.37	13.40
Coal consumed per kw.-hr. used, including heat and steam, lb.	37.3	27.7

In most hotels the size of the boiler plant (whether high-pressure or low-pressure boilers are used makes no difference) is fixed by the demands for heat and steam for laundry and kitchen. If electricity is purchased, the size or the cost of the necessary boiler plant is not as a rule changed at all. Therefore, when considering the question of generating electricity, care should be taken not to charge any of the fixed costs on the boiler plant to the generation of the current. This is an important truth which is generally overlooked and has led to many erroneous conclusions in the building and equipping of hotels.

Candy and Cracker Factory

From Robert A. Johnston Company, of Milwaukee, Wis., were obtained the power-plant data in Table III covering a period of one year. This company manufactures a complete line of candies and an assortment of crackers and fancy biscuits. A large quantity of high-pressure steam is used for cooking purposes, and during the hot weather a large amount of refrigeration is used. The refrigeration is produced by an absorption system using exhaust steam from the power-producing engines. About 500 kw. of electrical load is used throughout the factory, and a large amount of water is pumped from a deep well by means of an air lift. For about eight months in the year 3,500,000 cu.ft. of space is heated by exhaust steam.

The operating data in Table III are for the twelve months beginning June, 1924, and ending with May, 1925.

*From report presented at Annual Convention of National Association of Stationary Engineers at St. Paul by the Power Plant Cost Committee, consisting of Egbert Douglas, chairman, Charles F. Bindrich and Charles H. Bromley.

It is an interesting fact that this plant burns practically no more coal in winter than in the summer, and yet it has to heat 3,500,000 cu.ft. of space. During the winter months the exhaust steam is used for keeping the building warm, and during the summer months exhaust steam is used by the absorption refrigerating system for keeping the building cool in several departments.

Figures from Shoe Factory Plant

Nunn Bush & Weldon Shoe Company, of Milwaukee, Wis., furnish the data in Tables IV and V for its power plant for the year ending with May, 1925. The uses for steam outside of power and heating purposes are small, so that this plant presents an interesting example as to how cheaply a non-condensing steam plant can produce its power when using the exhaust steam for heating the building. The figures for operating the plant appear in Table IV.

TABLE III—OPERATING COSTS AND DATA IN CANDY FACTORY

Items	Item Cost	Per Cent of Total
Coal	$33,650	53
Operating labor	16,200	25
Repairs and maintenance	7,950	13
Lubricants and supplies	4,960	7
Water for plant	1,230	2
Total for 12 months	$63,990	100
Coal burned, tons		7,513
Total steam produced, lb.		77,631,638
High-pressure steam used for cooking, lb.		24,680,338
Percentage of total steam used for cooking		32
Coal cost per 100 lb. of steam made, cents		43.5
Steam made per pound of coal, lb.		5.2
Boiler-room labor cost per ton of coal burned, dollars		1.12
Electrical energy generated, kw.-hr.		1,442,540
Engine-room labor per kw.-hr. generated, mills		4.3
Space heated, cu.ft.		3,500,000
Steam used for power production, including plant auxiliaries and live steam make-up for heating per kw.-hr. generated, lb.		36

The factory buildings have a volume of approximately 1,750,000 cu.ft. of space which has to be heated about 7.5 to 8 months out of the year. Exhaust steam is used for heating when heat is required, and at other times the exhaust is wasted to the atmosphere. At times of extreme low temperatures all the exhaust is not sufficient to keep the buildings warm, and during such periods the deficit is made up with high-pressure steam through a reducing valve. The coal burned and the kilowatt-hours produced by months appear in Table V.

TABLE IV—OPERATING COSTS IN SHOE FACTORY

Items	Item Cost	Per Cent of Total Cost
(1) Coal, 1767 tons	$7,686	53
(2) Operating labor, 3 men, (Night man acts as night watchman also)	5,424	37.5
(3) Repairs and maintenance	526	9.5
(4) Lubricants	350	
(5) Miscellaneous supplies	300	
(6) Water for plant	200	
12 months total	$14,486	100

TABLE V—MONTHLY RECORDS OF COAL BURNED AND KW.-HR. OUTPUT

Months, 1924	Coal Burned, Tons	Kilowatt-Hours Generated	Months, 1925	Coal Burned, Tons	Kilowatt-Hours Generated
June	101	26,760	January	197	37,740
July	84	23,170	February	180	37,420
August	127	37,920	March	168	34,360
September	134	39,320	April	152	38,390
October	141	42,220	May	124	30,550
November	135	32,490			
December	224	33,490	12 months total	1,767	413,830

Large Office Building Plant

Operating figures and costs from the plant of the Federal Reserve Bank, of Cleveland, Ohio, for the year 1924 are given in Table VI. These figures are from the books of the superintendent of the building, who keeps his records so that he knows, and the owners of the property know, from day to day, just what the plant is doing.

TABLE VI—OPERATING COSTS AND MISCELLANEOUS STATISTICS FROM FEDERAL RESERVE BANK BUILDING IN CLEVELAND

Items	Item Cost	Per Cent of Total
Salaries	$11,356.71	30
Coal	24,723.55	66
Makeup water	219.55	
Supplies	742.45	4
Repairs, etc.	244.12	
Total cost of producing steam	$37,286.38	100
Miscellaneous Statistics		
Total water evaporated—V-notch meter, lb.	91,218,343	
Total coal consumed, lb.	10,484,832	
Water evaporation per lb. of coal, lb.	8.7	
Total cost per 1,000 lb. evaporated	$0.4082	
Coal cost per 1,000 lb. evaporated	$0.27	
Labor cost per 1,000 lb. evaporated	$0.124	
Kw.-hr. generated	1,356,798—100 per cent	
Kw.-hr. used by elevators	233,109—16 per cent	
Kw.-hr. used for lighting	513,995—38 per cent	
Kw.-hr. used for power	619,694—46 per cent	
Elevator travel, miles	27,642	
Kw.-hr. consumption per car mile (average per year)	8.07	
Annual peak load, kw.	500	
Annual load factor, per cent	31	
Coal burned per year per 1,000 cu.ft. of building space, lb.	1,747	
Kw.-hr. consumed per year per 1,000 cu.ft. of space (including both heat and electricity production)	226	
Boiler-room volume, cu.ft.	105,000	
Engine room volume, cu.ft.	85,000	
Total volume of power plant, cu.ft.	190,000	

The boiler-room space is about 1¾ per cent of the total volume of the building. This space would be required irrespective of where the electric power came

TABLE VIII—POWER PLANT RE

Month	Generated Current, Kw.-Hr.	Purchased Current, Kw.-Hr.	Total Current, Kw.-Hr.	Generated Steam, Lb.	Coal Used Lb.	Cost of Coal	Op... Expense			
							Salaries	Supplies	Repairs and Insurance	Wa...
January	53,590	20,740	74,830	8,847,290	1,020,000	$3,210.69	$895.95	$97.33		$2...
February	48,570	21,610	70,182	6,814,190	903,500	2,076.94	966.40	59.69	Repairs	615.4...
March	41,280	17,329	58,509	5,960,240	686,000	2,142.74	1,208.01	58.34	for	615.4...
April	48,260	9,244	57,504	5,644,700	665,000	1,523.45	959.17	8.21	Year, $706.10	725.5...
May	51,640	6,222	57,862	5,653,980	685,200	1,717.36	1,193.62	48.14		660.4...
June	53,430	6,962	60,392	4,809,725	567,500	1,276.76	963.39	43.46	Insurance	660.4...
July	40,790	7,878	48,668	3,329,370	512,338	1,355.99	969.22	53.03	$385.80	825.5...
August	42,790	7,900	50,690	4,226,675	556,796	1,108.64	998.16	50.20		660.4...
September	39,790	5,212	45,002	3,547,135	543,000	1,325.66	962.79	48.30		825.5...
October	38,680	5,421	44,101	3,855,850	667,750	1,233.68	1,008.19	57.29		660.4...
November	48,660	7,008	55,668	4,608,100	651,750	1,620.64	819.52	49.39		660.4...
December	51,960	4,723	56,683	5,930,110	814,750	1,839.19	878.58	49.88		660.4...
Total	559,440	120,251	679,691	63,227,365	8,273,584	$20,431.04	$11,823.00	$623.26	$1,091.90	$40...

*Steam corrected for high-pressure used, $8,534.07; Total value of steam, $49,634.05.

from. The engine space is less than 1½ per cent of the volume of the building, and the complete power-plant space occupying about 3 per cent of the total building volume, is in the basement and therefore of little value for renting.

Textile Plants

The Phoenix Hosiery Company in Milwaukee operates two large factories containing steam-power plants and two factories in which purchased electrical power is used. From the steam-power plants the following figures for one year's operation are available in Table VII.

Six days per week 60,000 gal. of soft water is heated by exhaust steam from an average temperature of 50 to 170 deg. for dyehouse uses. Approximately 90 per cent of the total steam made is used for purposes other than power production. The actual cost of electrical energy produced is computed at not more than ¾c. per kw.-hr., including all charges.

TABLE VII—OPERATING DATA FROM STEAM PLANTS OF PHOENIX HOSIERY COMPANY

	Building 4	Building 6
Fuel	$35,922.27	$46,737.33
Operating labor	13,913.97	13,321.36
Repairs and maintenance	2,167.54	1,231.28
Oils and miscellaneous supplies	1,103.75	933.19
Water	2,120.52	2,377.50
Total operating expenses	$55,228.05	$64,600.66
Coal burned, tons	7,735	9,700
Steam produced, lb.	141,687,000	182,360,000
Steam per pound of coal, lb.	9.1	9.4
Kilowatt-hours generated	740,460	580,650
Pounds of coal per kw.-hr.	21	33.5
Steam made per kilowatt-hour, lb.	190	314
Total space heated, cu.ft.	.....	7,854,000
Average electrical load factor, per cent	.....	42

In one of these plants for each kilowatt-hour of electricity required throughout the factory 190 lb. of steam has to be generated to take care of the power plus the other uses, and in the other plant for each kilowatt-hour of electricity required there is generated 314 lb. of steam.

The company has two factories in other buildings where steam is not required for manufacturing purposes, and the buildings are rented with heat furnished by the landlord. In these a large amount of power is used which is purchased from the central station at primary or transmission voltage, so that the lowest available rates are obtained.

In building No. 8 there was used in twelve months 809,252 kw.-hr. with a demand of 240 kw. and an average power factor of 74 per cent. The power cost for the period covered was $14,089.08, giving an average rate of 1.73c. per kw.-hr. for the purchased current. The labor incidental in the use of this power amounted to $2,000, bringing the total cost of the power as used to $16,089.08, equivalent to 1.98c. per kw.-hr. The annual load factor is 38.4 per cent.

In building No. 9 power is purchased under similar conditions. Here there was used in twelve months 725,600 kw.-hr., with a peak demand of 320 kw. and an annual load factor of 26 per cent. The power factor of this load is maintained with corrective condensers at 94 per cent, thus making the average rate lower than it would have been without them. In this plant the annual cost for power was $13,844.94, or 1.91c. per kw.-hr. With the necessary labor item of $1,820, the total cost appears as $15,664.94, or 2.16c. per kilowatt-hour.

It is of interest to point out that in the two plants where large quantities of steam have to be made for manufacturing purposes, the electrical power is produced for about ¾c. per kw.-hr., which is little more than one-third of what the purchased power is costing at the lowest available rates in the two plants buying power.

From the National Knitting Company of the same city the operating figures by months for the complete year of 1924 are available in Table VIII. This plant has a mixture of both alternating- and direct-current motors. Energy for the alternating-current motors is purchased at present because alternating generating equipment has not been installed. The energy for all the direct-current motors is generated by a pair of belted generators driven from a twin Corliss engine which has seen many years of service. While the plant is not of a design one would put in at this time, as it was installed more than twenty years ago, it has been maintained in excellent condition and is producing its service at a satisfactory profit.

By applying the prevailing rates for power and steam to the quantities this plant turns out and after allowing for other business-like charges, the plant shows a net profit of $23,000 in round figures per year. This is equivalent to about 25 per cent on the value of the plant as the company values it with its other property.

During the heating season of about eight months, exhaust steam is used to heat 2,477,244 cu.ft. of space. If both the steam and electric services of this plant had been purchased at the prevailing rates, the costs would have been 47 per cent more than the operating and maintenance expenses as calculated for the present power plant.

FOR 1924 OF NATIONAL KNITTING CO.

Expense				*Commercial Valuation of Services*					
Dep. Mach. and Equipment	Overhead on Bldgs.	Factory Overhead	Total Expense	Purchased Energy	Electric Energy	Steam at Low-Pressure Rates	One-half of Factory O. H.	Labor	Total
$615.43	$49.42	$586.20	$5,481.24	$670.88	$1,522.31	$5,750.73	$293.10	$290.00	$7,856.14
615.43	49.42	500.53	4,298.16	759.11	1,417.66	4,429.22	250.26	290.00	6,387.14
615.43	49.42	474.00	4,570.96	682.40	1,179.70	3,874.00	257.00	355.00	5,645.70
725.50	57.00	606.78	3,916.67	478.68	1,371.63	3,668.60	303.39	290.00	5,633.62
660.40	45.60	440.69	4,147.07	243.00	1,464.60	3,675.10	220.34	350.00	5,710.04
660.40	45.60	438.81	3,471.82	259.39	1,513.82	3,126.50	219.40	290.00	5,149.72
825.50	57.00	570.82	3,869.00	284.18	1,164.21	2,163.85	285.41	290.00	3,903.47
660.40	45.60	414.94	3,320.98	282.63	1,221.21	2,747.53	217.47	290.00	4,476.21
825.50	45.60	420.46	3,486.79	206.71	1,135.01	2,308.35	210.23	290.00	3,943.59
660.40	57.00	468.20	3,684.68	211.04	1,902.38	2,506.40	234.10	290.00	4,122.88
660.40	45.60	389.00	3,625.40	262.35	1,391.65	2,995.20	194.50	290.00	4,871.35
660.40	45.60	796.00	4,310.64	203.07	1,473.40	3,854.50	398.00	290.00	5,915.90
$8,185.19	$592.86	$6,106.43	$49,275.31	$4,573.44	$15,947.58	$41,099.98*	$3,063.20	$3,605.00	$63,615.76

Rehabilitation of Industrial Power Plant

THE extensive rehabilitation necessary in an isolated plant to keep it up-to-date is shown by the changes that have taken place during the last twenty years in the 3,000-kw. plant of the Walworth Manufacturing Co., manufacturer of valves and fittings, at Kewanee, Ill.

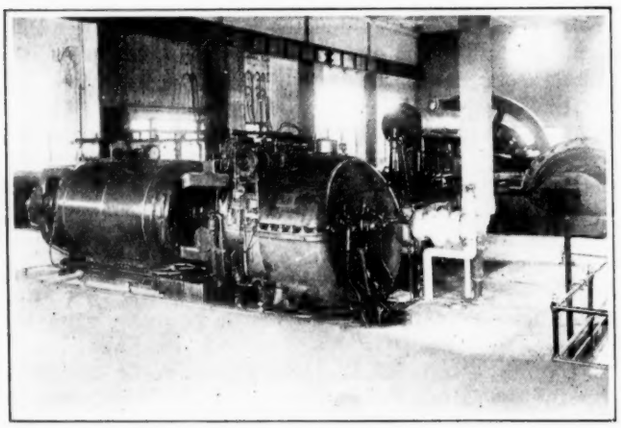


Fig. 1—This 2,500-kw. high-pressure 60-cycle turbo-generator occupies space taken by a 1,000-kw. low-pressure 25-cycle unit

During this period the power requirements of the plant have always been much greater than the capacity of the local central station and have included the pumping of considerable water for the municipal water system.

Twenty years ago practically all power was supplied by scattered steam engines, large quantities of steam being generated in waste-heat boilers attached to furnaces used in the manufacture of wrought pipe. When the manufacture of pipe was discontinued, the scattered steam engines were replaced with direct-current motors taking power from a 550-kw. engine-driven generator, several belted units supplying lighting service and two straight-line steam-driven air compressors supplying compressed air.

In 1909 the growth of the electric load called for more generating equipment and a 1,000-kw. 25-cycle 480-volt low-pressure turbo-generator was installed, utilizing exhaust steam from the engine-driven unit and the two compressors. The steam pressure then available was 80 lb., saturated, and practically all generating equipment was designed for 100 lb. pressure. In 1913 a new boiler house was built and the steam pressure raised to 175 lb. with 80 deg. of superheat, the only change in power-plant equipment being the addition of a high-pressure cylinder to the 550-kw. engine set, making it tandem-compound.

It was decided in 1913, to eliminate the 25-cycle equipment that had been installed 13 years before and adopt 60 cycles as standard. In addition to offering greater ranges of motor speed, more ample stocks and lower first cost of equipment, the change to 60 cycles permitted the installation of a 2,500-kw. high-pressure generating unit in the same space occupied by the 1,000-kw. 25-cycle low-pressure unit originally installed. The straight-line air compressors originally designed for 100-lb. air pressure and 100-lb. steam pressure had been subjected to increasing demands until air was being delivered at 140 lb. and steam supplied at 175 lb. pressure. Because of a considerable saving in space and the desirability of raising the power factor of the entire electric system, a synchronous-motor-driven air compressor was installed. This has a capacity of 2,500 cu.ft. of free air per minute at 140 lb. gage and occupies the floor space previously required by two steam-driven compressors. As the motor runs at constant speed, the air discharge pressure is controlled by an automatic five-step regulator, the first step acting on the principle of cylinder clearance, the remaining steps effecting control by holding open the air-inlet valve on the low- and high-pressure cylinders.

The present 2,500-kw. high-pressure turbine is of the bleeder or extraction type, using steam through the high-pressure stages for power and extracting at five pounds pressure for plant heating. A vacuum system of heating was installed throughout the plant, the condensate being returned to the boiler plant.

When the change was made to 60 cycles, the former plan of using one large motor in each department was modified by providing a large number of small rating motors, dividing the machinery into smaller groups that would better meet the demands of production.

During the four weeks required to make the change from 25-cycle to 60-cycle equipment and to install the new air compressor, auxiliary power to the amount of 500 kw. was obtained from the local central station. New 60-cycle motors to the extent of about 500 kw. were placed in position before the existing equipment was removed. One-half of the works operated on night turn during the time of changeover. It was thus possible to continue production without interruption.

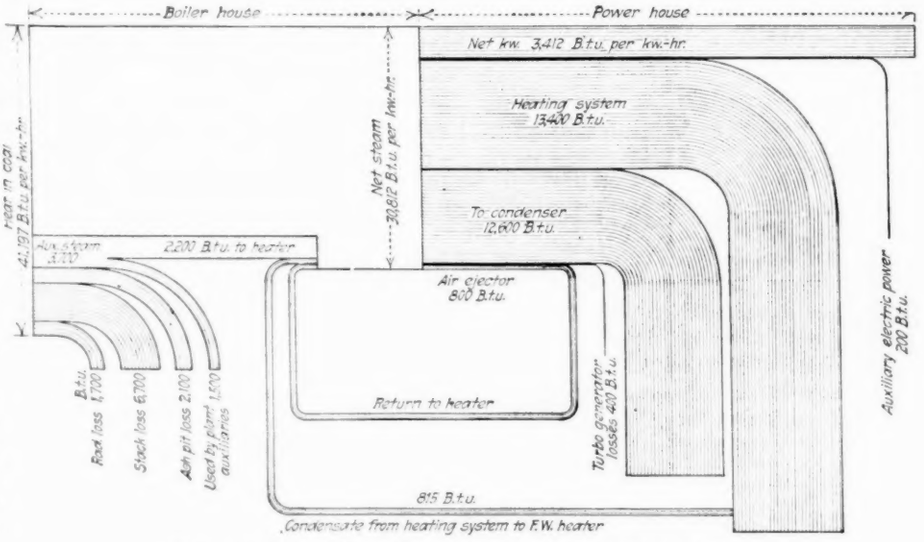
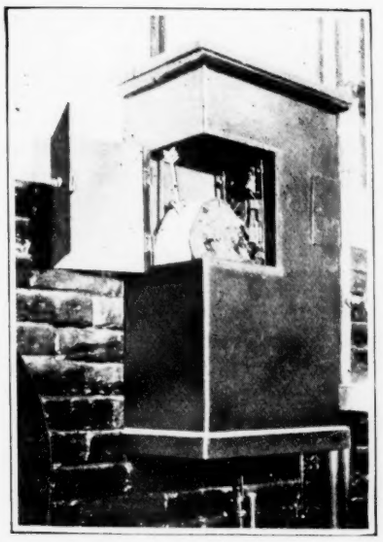

Boiler house
Power house
Net kw. 3,412 B.t.u. per kw.-hr.
Heat in coal 41,197 B.t.u. per kw.-hr.
Net steam 30,612 B.t.u. per kw.-hr.
Heating system 13,400 B.t.u.
To condenser 12,600 B.t.u.
Raw steam 3,000
2200 B.t.u. to heater
Air ejector 800 B.t.u.
Auxiliary electric power 200 B.t.u.
B.t.u. 1,700
Rust loss 1,700
Stack loss 6,700
Ash pit loss 2,100
Used by plant auxiliaries 1,510
Return to heater
Turbo generator losses 410 B.t.u.
815 B.t.u.
Condensate from heating system to F.W. heater

Fig. 2—Heat-flow diagram showing distribution of steam for electric generation in addition to building heating and other uses

Weighing Coal at Strathmore Plant

At the Mitteneague (Mass.) plant of Strathmore Paper Company coal weighing is semi-automatic. Standard load indicated by simultaneous illumination of two lights on sealed scale case.

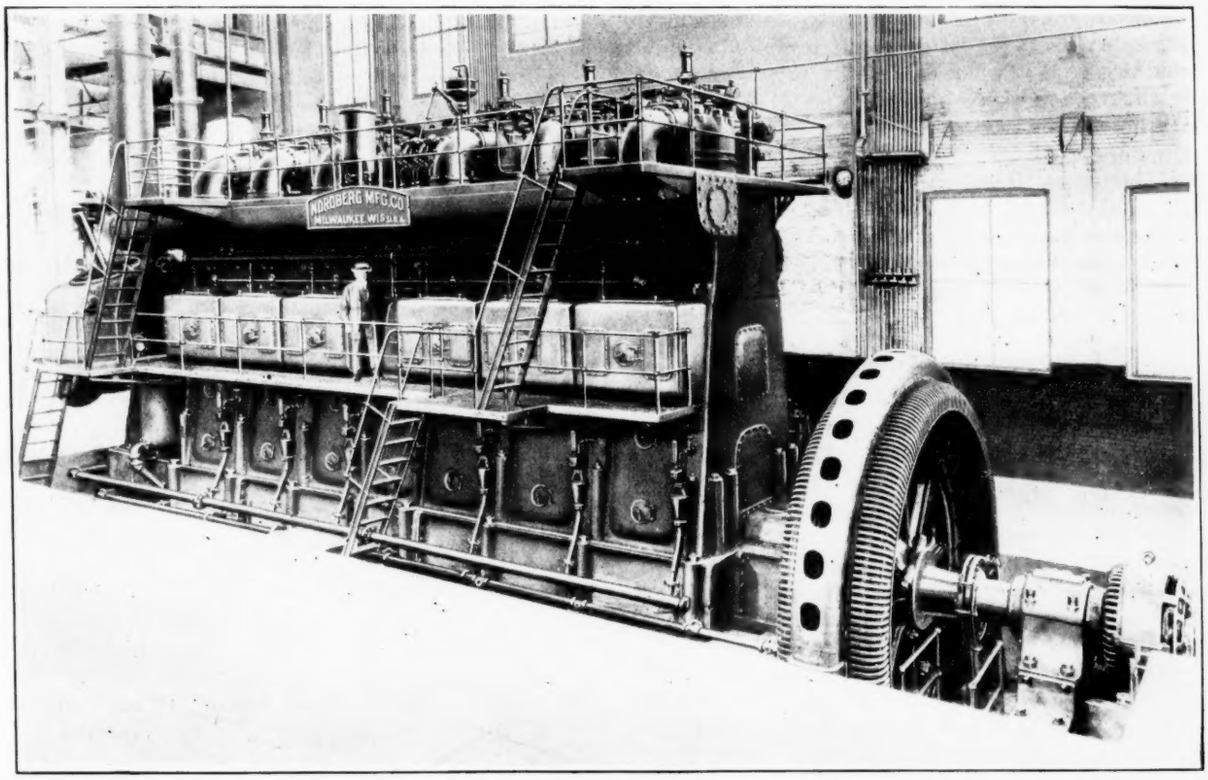


Above—Instrument in engine room records coal weighings

When both lights are on at the scales, the instrument pen is displaced, making a jog in line. System installed under the supervision of Walter N. Polakov.

Below—America's largest Diesels to operate canal

As a stand-by for the hydro-electric power which normally operates the Panama Canal, three Nordberg Diesel engines (of which this is the first) will be installed with a combined capacity exceeding 12,000 hp. The individual rated capacity of 3,750 hp. and overload capacity of 4,125 hp. set new American records for Diesel engines. There are six cylinders, 29-in. bore, 44-in. stroke. The speed is 125 r.p.m. The unit weighs 1,000,000 lb. with generator. It is 22 ft. 6 in. high above floor line and 62 ft. long.



How Dirty Fuel May Damage Oil-Engine Cylinders

By A. B. Newell

IT OFTEN happens that an engineer in trouble is too quick to adopt any suggestion as to the remedy to be used. Thus when the theory is presented that abrasives in the fuel are causing the excessive cylinder wear, he believes it, even though he should know the theory to be false in part.

One of the worst cases with which I have had to deal was in an engine with cylinders of 22-in. bore and 36-in. stroke, where the extreme wear was found 5 in. down from the highest point of piston-ring travel. The total wear at this point had increased the cylinder diameter by 0.145 in., the metal removed being 0.0725 in. thick. At the bottom end of the ring travel the wear amounted to 0.005 in. and it was 0.020 in. halfway up the cylinder. The cylinder was not more than 0.005 in. out of round at any point, and there was no indication of seizures. Observations of this wear were taken over a period of four years at intervals of not more than nine months. The engine was in operation approximately 75 per cent of that time, and the wear was found to be continuous.

Abrasives Not the Cause

If an abrasive in the fuel was the cause of this wear, it is reasonable to suppose that it would have extended the length of piston travel, or at least the wear at the lower end of the cylinder would have been considerably more than was found. Most reports of abnormal cylinder wear indicate that it takes place in about the same manner.

Engines burning dirty fuel always show abnormal cylinder wear, thus the wear ultimately is traceable to the foreign substances just as surely as the absence of abnormal wear at the lower end of the cylinder indicates that the abrasive in the fuel is not directly causing the trouble.

Fuel pumps, fuel valves and their atomizers, as well as flame plates on injection nozzles, get out of order when sand is present in the fuel. In very bad cases exhaust valves have been known to give trouble from the same cause, indicating that the sand in being expelled at a high velocity along with the gases, cuts the comparatively narrow seats.

Result of Poor Combustion

When the fuel pumps and atomizing devices get out of order, poor combustion follows. This interferes with lubrication of the cylinder walls because the soot present tends to dry the oil film. An additional supply of oil loads up the rings, and since it is introduced at the lower end of the cylinder, lubrication is best at that point. As the piston travels upward in the cylinder, a certain amount of soot and unburned fuel works down around the top ring and causes it to stick. The same happens to the second and third rings, this process continuing until the working rings are so far from the combustion space that the gases lose their heat between the piston and cylinder wall and lubrication becomes effective.

Once the fuel pumps, atomizers and flame plates are cleaned and combustion becomes normal, excessive wear will stop provided the rings are made free and lubrication is restored. Naturally, if the abrasive again destroys the atomizing devices, a repetition of the unsatisfactory operation will occur.

Then sand actually does put the fuel pumps and various parts of the fuel valves out of commission, and to overcome the difficulties, it is necessary that the abrasive be removed from the fuel before the oil reaches the pumps. It is best to give more attention to the condition of combustion and equal distribution of fuel to each cylinder than to be drawing and cleaning pistons, thinking that they are loaded with sand when in reality the grit is nothing more nor less than hard carbon. Naturally, if the pistons are allowed to get badly carbonized, it is necessary that they be cleaned.

Better Lubrication Needed

Returning to the question of cylinder wear. There is what is commonly termed a normal amount in all oil-engine cylinders. That this is more than it will be when the engine reaches a finer state of manufacture, and considerably less than it was a number of years ago, is a well-known fact. The whole problem seems to center about lubrication. There are a few exceptional cases of poor material, but they are becoming very few indeed. Granting that it is a question of lubrication, there is room for a vast improvement, not so much in the quality of the lubricant as in the method of application.

Although timed cylinder lubrication is claimed by a number of engine builders, a little study of the methods employed indicates that the timing is not effective. An example is where oil is accurately timed to pass out of a check valve in the cylinder wall, but a space between the check valve and piston exists and the oil must flow of its own accord into the rings. We do not know how fast the oil will flow across the gap. In fact, it does not flow across the gap at all, but goes trickling down the cylinder wall, sometimes just in time to spread while the piston has the opening uncovered. This applies to engines with short pistons; those of the trunk type keep the point of oil entry covered at all times.

Where the Oil Goes

I have watched the oil come out of the opening in the cylinder wall and flow over the edge of the hole just in time to have the piston come down and the lower ring scrape it away. This happened on a slow-speed crosshead-type engine turning at 90 r.p.m. The timing in that instance was useless. The lubricator delivered a drop of oil to within $\frac{1}{4}$ in. of the piston on that engine. I do not know whether I saw the drop that was intended for that particular stroke of the piston or the one that was intended for the previous stroke, but am inclined to think it was the latter. Oil will not flow very far in one-third of a second, which is the time interval between strokes of the piston at that speed.

Another factor that destroys timing is the use of a lubricating pump not having a solid body of liquid between the plunger and the check valve in the cylinder wall. Some pump a certain amount of air along with the oil and an elastic cushion is thus formed in the oil pipe. These inaccuracies of timing cannot be overcome in operation and they cannot be charged to the operator. The best he can do is to feed in such quan-

tity as to obtain the best lubrication of the cylinders that is possible. However, he can help the situation when pistons are out for cleaning, by keeping the lower edges of the rings rounded so that the oil will not be carried down the cylinder wall. Oil pumping in the automobile engine is not to be desired, but with oil engines of the long-stroke type the situation is different.

If a nozzle could be extended through and flush with the cylinder wall and have an orifice in the end just large enough to let a fraction of a drop through, but at the same time offer a restriction in the form of a check valve which would hold the oil exactly at the point of delivery, it might be possible to accomplish effective timing. The objection to having a nozzle so fine is that it would be too small to permit a flooding or rapid delivery of oil in an emergency. It is not likely that this important point has not been thought of by engine manufacturers, although I have never heard of any of them experimenting with such a device.

One of the most important factors of operation is to recognize the difference between a normal condition and an abnormal one. Since the latter is entirely within the control of the operator, every precaution should be taken to eliminate it.

Storing Spare Armature Coils

By N. L. Rea*

Every automobile owner appreciates the necessity of spare tires and arranges to keep one or more always ready for emergencies. These spares are protected from ageing or accidental injury as far as possible. On the other hand, the motorist may be a power-plant operator and run his generators for years without a thought of spare coils, or, if spare coils are carried, they have to run their chances with all kinds of stock.

Coils have been stored in the upper part of a boiler room and, when badly needed, the insulation was so brittle they could not be used. It doesn't do coils any good to put them in a dark corner of the stockroom and throw short pieces of pipe and miscellaneous scrap iron on them.

In another case coils were put in a shed, covered with a sheet-iron roof and siding, outside the power house. In the summer this shed probably reached temperatures of around 130 deg. F. and winter nights went as low as 35 to 40 deg. below zero. The high summer temperatures baked out the insulation; but, worse yet, the freezing and thawing separated the various layers of the insulation sufficiently to make them too large for the slots.

Many other instances of "how not to store coils" could be given, but perhaps recommendations of the proper method will be sufficient without a long list of horrible examples.

The spare coils should be protected from mechanical injury and from squirrels, rats, mice and, in some localities, white ants or other destructive insects. They must also be protected from dampness, from heat and from excessive changes in temperature. They should be kept from freezing. These conditions are best met by clean, dry storage in a room having moderate temperature and no excessive or sudden changes of temperatures. Even where the conditions are ideal, the varnishes and compounds used in the insulation will gradually age and harden. This can be delayed greatly by the following treatment:

Snugly tape the exposed copper at the coil ends and then coat the entire coil with melted paraffin. Special pains should be taken with the taped ends to prevent the entrance of moisture. Small coils can be dipped or the melted paraffin can be applied with a brush.

If the coils are already covered with a protective layer of cotton tape or burlap, the hot paraffin can be brushed on over this protection. This treatment keeps out moisture and, what is more important, prevents the drying and hardening of the compounds used in the insulation.

When the coils are needed, it is an easy matter to remove the paraffin from the ends with gasoline or carbon tetrachloride. A little paraffin on the slot portion will help a lot in getting the coils in the armature slots.

The coils should be cleaned and warmed thoroughly before being placed in an armature. They should be hot enough to soften the insulation thoroughly before they are put in the machine or bent after they are in place. This can be done by heating them in an oven or by passing current through them. Fifty to seventy-five per cent of the current flowing through the coils at full load is about right. If the winding is multiple circuit, the current through the individual coils is the full-load current of the machine divided by the number of circuits in multiple.

Care should be taken not to ruin the coil by too much current. It is possible to heat the copper nearly red hot and destroy the insulation between the turns before the outside of the coil shows any appreciable rise in temperature. It is advisable to go slowly on the first coil until the proper amount of current is determined.

Approximately five minutes' application should heat the bare copper at the ends of the coil enough to be uncomfortable to the hand. The outside of the coil will probably be just warm to the hand, but the internal temperatures are much higher and the heat will carry through after the current is cut off.

*Contract Service Department, General Electric Company.

Coal burns more readily in pulverized form than in the lump because so much more surface is presented for the action of oxygen. A sphere of coal one inch in diameter has a surface area of 3.14 sq.in. If the same amount of coal were ground into spheres of 0.01 in. in diameter, the area would be increased to 314 sq.in. Also if one cubic inch of coal were divided into smaller cubes each 0.01 in. to the side, there would be 1,000,000 such little cubes and the whole of them would expose a surface of 600 sq.in., or 100 times as great as that of the original cube.

In oil-burning plants it is usual for the fireman to be instructed to have the stack gas show a faint haze. This is not because such a haze denotes perfect or the best combustion. If the stack shows clear, it is impossible to know how much, if any, excess air is being used. A smoking stack is evidence of a lack of air, and by reducing the smoke to a mere haze the fireman knows that he has reduced the loss due to unburnt fuel to the lowest amount that can be indicated, although a clear stack might actually be giving a gerater efficiency.

Coos Bay plant of the Mountain States Power Co.

Burning Hog Fuel at Coos Bay Plant

Inclined, Stepped Grates with Dutch Ovens and Special Arches; 565 Kw.-Hr. from Fuel Unit of 200 Cu.Ft. on 10 Per Cent Load Factor

IN THE Northwest the Mountain States Power Company, a Byllesby property, owns and operates four groups of utilities in Oregon, Washington, Montana and Idaho and quite recently has acquired a fifth property in Wyoming. In the Coos Bay Division, with headquarters at Marshfield, Ore., which is an important shipping and lumber center, a new power plant has been built that eventually will take over the entire load of the division, which heretofore has been dependent entirely on purchased current. The initial installation consists of but one unit of 6,250 kva. capacity served by two boilers. It is being operated eight to nine hours per day during the heavy-load period, and carries up to 5,000 kw., although the average load seldom exceeds much more than one-half of the foregoing figure and is carried by one boiler operating at 200 to 225 per cent of rating. For the balance of the 24 hours the service is purchased as before.

Special Furnace Design

The interesting feature of the plant is a special furnace design incorporating an inclined, stepped grate for burning hog fuel. Practically all hog fuel in this district has been burned in Dutch ovens with flat grates having four or more openings in the furnace roof through which the fuel is fed to the furnace in cone-shaped piles for surface burning.

Fuel in use is the waste from fir, spruce, hemlock, pine and the less desirable redwood. It is shredded in "hogs" at the mills and in the present case is conveyed to the plant by barge. The heat value ranges from 5,500 B.t.u., per lb., wet, to something over 9,000 B.t.u. per lb., dry. The moisture varies from 35 to 65 per cent. Per unit the weight will range from 2,400 to 5,000 lb., the average unit weighing in the neighhood of 4,000 lb. and containing approximately 42 per cent moisture. The average weight dry approximates 12 lb. to the cubic foot., or 2,400 lb. per unit.

Monthly averages obtained with the new furnace, at a load factor of about 10 per cent, have approxi mated 565 kw.-hr. per unit of 200 cu.ft. Fig. 1 shows

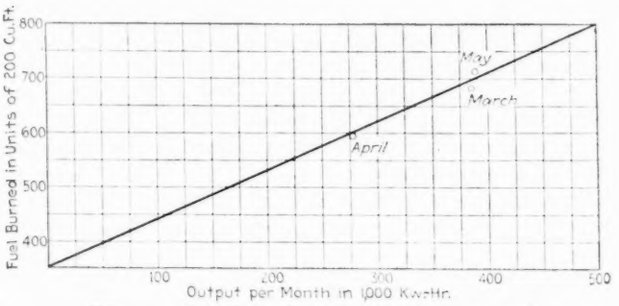


Fig. 1—Results obtained with hog fuel

the results obtained during three months' operation. This fuel-load curve is a straight line and as each additional 100,000 kw.-hr. calls for 90 units of fuel, the probabilities are that at 60 per cent load factor, 900 to 1,000 kw.-hr. will be produced on a unit of fuel. These results are from a plant operating at moderate pressure and superheat without economizers and other refinements, not warranted with the fuel costing, delivered, $1 or less per unit of 200 cu.ft.

In the boiler room are two boilers of the Stirling type, each containing 6,095 sq.ft. of steam making surface and equipped with convection superheaters located between the first and second banks of tubes. The operating pressure is 250 lb. gage, superheat 250 deg. F., and the final steam temperature 606 deg. F. Plans have been made for extension, first across the firing aisle and then lengthwise of the boiler room. There is provision also to adopt the installation for coal burning should this be desirable at any time. This applies not only to the base of the boiler setting, but also to the building steel work which has been arranged to take overhead coal bunkers.

An unlined steel stack 8 ft. in diameter and 225 ft. high above the boiler-room floor provides natural draft. It rests on a structural-steel base tied in with the building steel. An unusual feature is the guying of a stack of this height. Guy cables are attached at eight points and secured to four anchors spaced 90 deg. apart, with minimum initial tension on the cables to keep down the load on the roof steel.

Steam leads from the boilers are brought to a short steel manifold just long enough to receive the various connections. For example, when boilers are installed across the aisle they will be piped to this manifold and connection may be made also to additional units installed along the firing aisle. The steam supply for the turbine is taken from the end of the manifold, the pipe making a long radius bend at the same level as the manifold and passing to a steam separator in front of the throttle. Steel valves with Monel trim and steel fittings are used in the high-pressure lines.

Feed water for the boilers is mostly condensate pumped back through the inter and after coolers of the condenser air evactors to an open feed-water heater mounted on a platform in the turbine room about 10 ft. above the operating platform and 25 ft. above the boiler-feed pumps on the first flood. From the heater the water passes first through a V-notch meter and then to either one of two turbine-driven boiler feed pumps each with a double discharge formed by a special U fitting. One leg of the U passes to the main feed-water header and the other to the auxiliary header, the lines being valved so that the supply can be sent to either header and from there to the boilers under control of feed-water regulators. The headers are cross-connected and the regulators bypassed, so that accident to any particular section of the line need not interfere with the flow to the boilers.

When it came to designing a furnace for the burning of hog fuel, the inclined, stepped grate with the proper arch construction, seemed to possess certain advantages over the usual type of Dutch oven equipped with the ordinary, horizontal grate. The grates are inclined at

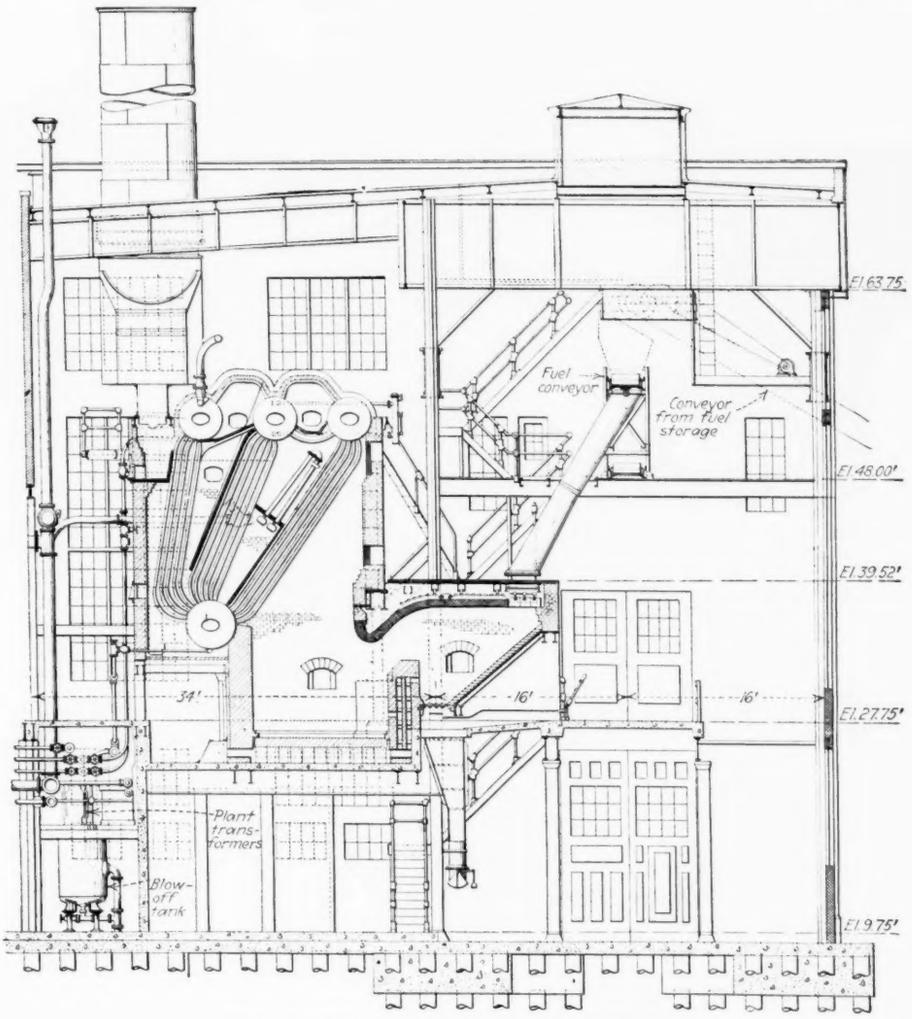


Fig. 2—Sectional elevation through plant

an angle of 42 deg. with the horizontal, which is slightly more than the angle of repose for the material in question, so that the fuel flows down by gravity and is held by the rocking dump grate at the base and the bridge wall. An arch of the shape shown in Fig. 2 is used to reflect the heat onto the fuel to evaporate the moisture, improve ignition and distill the volatile gases. On the flat rocking grate is an incandescent bed of fuel. Curving downward at the inner end into a drop nose, the arch is carried past the bridge wall to form a restricted throat for the better mixing of the secondary air with the products of combustion and for directing the burning gases downward to increase the flame travel. The gases expand through this restricted area and the upward turn at right angles in the combustion chamber further improves the mixture.

Secondary air is introduced through two layers of tile ducts at the base of the combustion chamber, covered by 9 in. of firebrick. Entering the inlet box at the rear through a series of regulated dampers, the air passes through passages in the rear wall into the tile ducts, thence up into the bridge wall through two series of tuyeres, one delivering secondary air into the furnace and the other into the combustion chamber. In its passage the air is preheated and secondary advantages are the cooling of the supporting floor and the reduction of radiation.

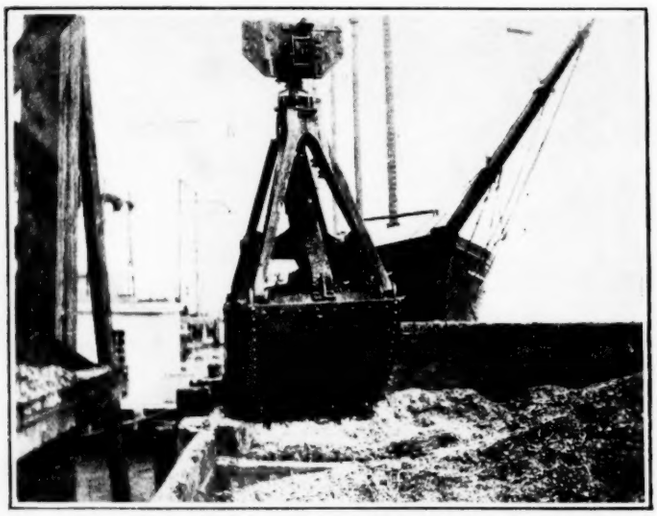


Fig. 3—Unloading barge of hog fuel by means of a clamshell bucket

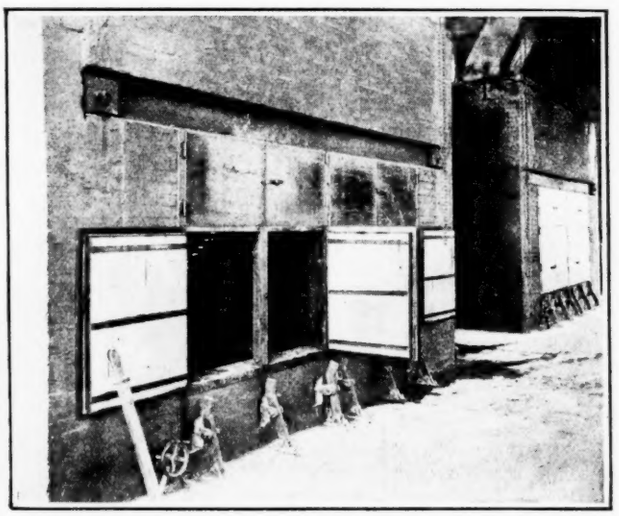


Fig. 4—Furnace fronts closed in to improve banking conditions

Furnace Fronts Are Closed in

Primary air enters through the inclined grate. Originally the Dutch ovens had open fronts, but it was found necessary to enclose them and put in doors to give better control of the boilers on bank, as the closing of the damper at the uptake would not stop steaming.

Fuel is introduced at the front of the furnace through two spouts from which it falls onto the grates and works its way down as it burns. It was soon found that the fuel would form in two cones with a slight valley between, giving an uneven fuel bed. Conditions were improved by inserting a channel protected by firebrick across the furnace in line with the trailing edges of the chutes and at a definite height to act as a gate for regulating the thickness of the fuel bed.

When the furnace was designed it was expected that combustion of the fuel would be completed largely on the inclined grate within the Dutch oven. In practice, however, the lighter portions of the fuel passed over the bridge wall with the gases and combustion chamber in the rear. Although results obtained are excellent when compared with former practice, the indications are that certain furnace modifications contemplated will result in improvement.

No Ash or Fuel Sifts Through the Grate

With the construction used there is no shifting of ash or fuel through the grates. The slag that does form on the grates can be removed during operation by slice bars pushed through the vertical grate openings. This slag and the cinders that may collect are projected through the dump grate by shaking levers at the furnace front into a brick-lined steel ashpit with a swinging gate through which the refuse is discharged into cars and carried out onto the plant site for filling purposes.

On account of the fire risk and the bulk of the fuel, storage was provided in a separate building having capacity to hold 7,000 units. For the present plant operating at maximum capacity, this will provide storage for about six weeks, but on the present basis of operation the house will store enough fuel to last for several months. With enough combustible to destroy any type of building in case of fire, the house was built of wood as this is the cheapest material in the district that could have been used.

This separation of the two buildings made an interesting conveying problem. The fuel is unloaded from the boat by a clam-shell bucket operating from a trolley on a boom swung from the unloading tower. The necessary drums and sheaves are provided and the equipment is motor driven. Delivery from the bucket is made into lined steel hoppers from which the fuel passes onto an inclined flight conveyor which carries it to an elevation corresponding to the top of the fuel house, where transfer is made to a distributing belt conveyor running the full length of the storage. Running parallel is the recovery conveyor of the scraper

type below the storage. The storage house has an inclined bottom down to the floor over this conveyor. This floor is made up of movable planks which can be shifted according to the location of the fuel in the house, so that the conveyor will always receive a supply.

At the end of the house opposite to that from which it is received, the fuel on the recovery conveyor is discharged to a second inclined flight conveyor leading to the top of the boiler room where delivery is made to an endless scraper conveyor located over the center of the firing aisle. Through gates in the bottom of the trough for the upper run of this endless conveyor, delivery is made to the furnaces, there being two chutes per furnace as previously stated. All conveyors have capacity in excess of the maximum requirements of the furnaces and whatever fuel is not taken by the furnaces, drops through chutes from the upper to the lower run of the endless conveyor in the boiler room and is carried back again to the upper run. When too much of the fuel is being recirculated, the fireman presses a control button, stopping the recovery conveyors in unison. Proper regulation of the fuel requires the services at all times of one man in the boiler room and a second in the fuel-storage house.

In the turbine room the one machine now in operation is rated at 5,000 kw. at 80 per cent power factor. Three-phase, 60-cycle current is generated at 11,000 volts. Excitation is furnished by a turbine-driven exciter on the first floor. The condenser is of the surface type with 8,000 sq.ft. of surface. Of the auxiliaries there is no duplication, but a division is made between steam and electric drive to maintain the heat balance.

Salt water from the bay is used for cooling. In the condensers Admiralty tubes from Byllesby specifications, such as are used in all other plants of the company, are employed. The motor-driven circulating pump is set in a pit to equalize the head between the suction and discharge sides.

The plant was designed and constructed by the Byllesby Engineering & Management Corporation, of which H. W. Fuller is vice-president and chief engineer; F. H. Lane, manager of engineering and construction; H. Boyd Brydon, mechanical engineer and A. H. Tracy, electrical engineer.

PRINCIPAL EQUIPMENT OF COOS BAY STATION OF MOUNTAIN STATES POWER CO.

Location of plant	Marshfield, Ore.
Capacity present building, kw.	5,000
Width of firing aisle, ft	9
Ratio boiler heating surface to boiler room floor area	3.24 to 1
Ratio kilowatt rating to turbine-room floor area	1.95 to 1

BOILERS AND SUPERHEATERS

Manufacturer	Babcock & Wilcox Co.
Number of boilers	3
Type	Stirling bent-tube, 3-pass
Steam making surface, sq.ft.	6,095
Working pressure, lb. gage	250
Superheat, deg. F.	200
Steam temperature, deg. F.	606
Superheater, Foster convection	Power Specialty Co.
Furnace volume, cu.ft.	3,035
Furnace volume per sq.ft. of h.s., cu.ft.	0.497
Furnace	Dutch oven
Arches	M. H. Detrick Co.
Inclined and shaking grates	Western Foundry Co.
Area shaking grates, sq.ft.	26
Area inclined grates, sq.ft.	130
Ash hopper gates	Link Belt Co.
Firebrick and baffles	Idaho Firebrick Co.

STACK

Manufacturer	Minneapolis Steel & Mach. Co.
Type	Steel, guyed
Diameter ft.	8
Height above boiler room floor, ft.	225

PUMPS

Boiler feed, two 4-stage	Cameron Steam Pump Works
Capacity of each g.p.m.	200
Drive, 80-hp. turbine	Terry Steam Turbine Co.
Boiler wash, one 160 g.p.m.	Cameron Steam Pump Works
Drive 40-hp. motor, 1,800 r.p.m.	Westirghouse Elec. & Mfg. Co.

FEED WATER HEATER AND METER

Manufacturer	Worthington Pump & Mach. Corp.
Type	Open, 2 section, Stilwell
Number	1
Capacity, lb. per hr.	70,000
Meter, V-notch	Bailey Meter Co.
Capacity, lb. per hr.	75,000

HOG FUEL HANDLING

Unloading apparatus, 5-ton elec. hoist with 1¼ yd. Blaw-Knox clam shell bucket and inclined drag conveyor to fuel house	Lewis & Watts Engineers
Conveyors	Chain Belt Co.
Inclined conveyor, 65 f.p.m.	40 tons per hr.
Distributing conveyor, 200 f.p.m.	40 tons per hr.
Recovery conveyor, 60 f.p.m.	40 tons per hr.
Boiler room conveyor, 70 f.p.m.	40 tons per hr.
Drives, induction motors	Westinghouse Elec. & Mfg. Co.
Boiler house fuel chutes	Chain Belt Co.

TURBO-GENERATOR

Manufacturer	General Electric Co.
Number	1
Capacity, kw. at 0.8 p.f.	5,000
Steam pressure at throttle, lb. gage	225
Superheat at throttle, deg. F	200
Generator	3-ph., 60-cycle, 11,000-volt

TURBO-GENERATOR—Continued

Speed, r.p.m.	3,600		
Air filter, 20,000 cu.ft. per min.	Midwest Co.		
Guaranteed water rates, foregoing steam cond. and vac. 1 lb. abs.			
Load, kw.	5,000	3,750	2,500
Lb. steam per kw.-hr.	11.85	12.0	12.6
Exciter, 50 kw., 3,000 r.p.m.	General Elec. Co.		
Drive, turbine	General Elec. Co.		

CONDENSERS AND AUXILIARIES

Manufacturer	C. H. Wheeler Mfg. Co.
Number	1
Surface, sq.ft.	8,000
Surface per kw. of rating	1.6
Capacity, lb. steam per hr.	67,500
Condenser tubes	Chase Metal Works
Feather check valve in air line	Worthington Pump & Mach. Corp.
Circulating pump, g.p.m.	11,000
Drive, 75-hp., 2,300-v. motor	Westinghouse Elec. & Mfg. Co.
Vacuum pump	Two-stage Radojet with inter and after coolers
Hot well pump	162 g.p.m., Terry turoine drive
Water screen, revolving	Chain Belt Company
Screen wash pump	Yeoman Bros., Co.

MISCELLANEOUS MECHANICAL EQUIPMENT

Turbine room crane, 30 ton, 3 motor	Whiting Corporation
Oil filtering system, continuous by-pass	S. F. Bowser & Co., Inc.
Piping and valves	Crane Company
Pipe covering	Smith, Totman Co.
Circulating water piping	U. S. Cast Iron Pipe Co.
Blowoff valves	B. & W. Angle Valves and Merco-Nordstrom, Cocks
Safety valves	Crane Co.
Water columns, wrought steel, high and low water alarms	Babcock & Wilcox Co.
Soot blowers	Diamond Power Specialty Co.
Feed water regulators, Copes	Northern Equipment Company
Pump governors, Mercon	D. H. Skeen & Co.
Steel work fabricated by	Minneapolis Steel & Mach. Co.
High Rib and window operators	Truscon Steel Co.
Sliding steel doors	Voightman & Co.
Skylights	Sykes Co.
Subway grating	Irving Iron Works
Plumbing	Crane Co.
Roof tank	Redwood Mfg. Co.

STATION INSTRUMENTS

Steam flow meters	Bailey Meter Co.
Draft gages, 5 pointer	Bailey Meter Co.
Recording thermometers	Taylor Instrument Co.
Mercury indicating thermometers	C. J. Tagliabue Mfg., Co.
Indicating pressure gages	Ashcroft Mfg., Co.
Recording gages, press. and temp.	The Bristol Co.
Condenser leakage meter	Esterline Angus Co.
Barometer and vacuum gage	Precision Thermometer & Ins., Co.

ELECTRICAL EQUIPMENT

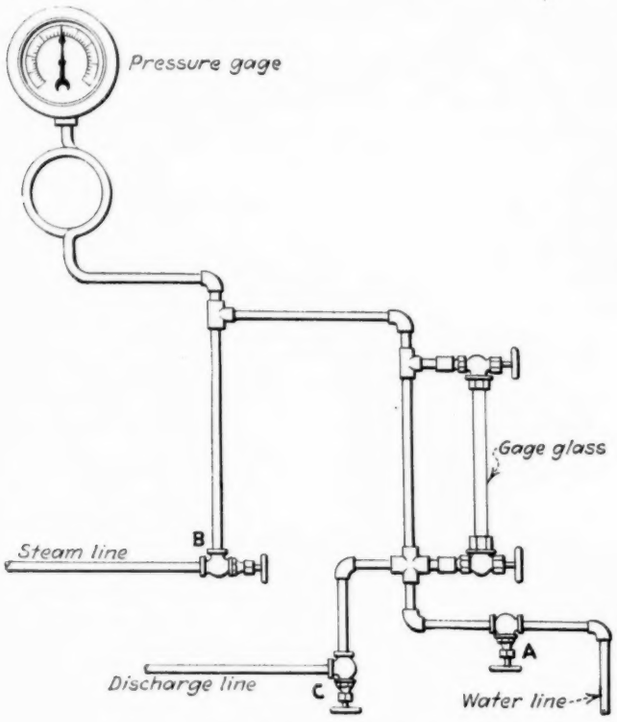
Switchboard	Westinghouse Elec. & Mfg., Co.
Motors	General Electric Company; Westinghouse Elec. & Mfg., Co.
Transformers	General Electric Company
Oil circuit breakers	Westinghouse Elec. & Mfg., Co.; General Electric Company
Disconnecting sw. and bus supports	Delta Star Elec. Co.
Current and potential transformers	Westinghouse Elec. & Mfg., Co.
Lighting arresters	General Electric Company
Storage battery	Electric Storage Battery Co.

Testing of High-Pressure Boiler Tubular Gage Glasses

By T. G. O'Niell*

TO WITHSTAND satisfactorily the high steam pressures in common use at the present time, tubular gage glasses must be made of a good grade of glass and be free of internal strains.

The Engineering Experiment Station at the Naval Academy endeavored to devise a satisfactory dipping test, which would discriminate between satisfactory and unsatisfactory glasses. Two samples from each of twelve different brands of gage glasses were heated in



Apparatus used in making shock test

lubricating oil at a temperature of 400 deg. for 2 minutes and were then immediately immersed in water at a temperature of 40 deg. F. This test was repeated twenty times, but none gave any indication of cracking or breaking. Since this test was more severe than any of the "dipping tests" generally in use and since all the glasses withstood this test, it was apparent that the results of such a test can be of no value in discriminating between satisfactory and unsatisfactory samples.

The station then devised a so-called "steam shock test," which has proved satisfactory. The test is simple and replaces the long service-endurance tests. A diagram of the apparatus used for the test appears in the illustration.

The conduct of the test is as follows: The glass to be tested is installed in the fittings, and the valve *A* in the water line is opened until the glass becomes half filled with water at a temperature of 75 deg.; the quick-opening valve *B* in the steam line is then opened, and the glass is suddenly subjected to steam at a pressure of 275 lb. gage. At the end of one minute the quick-opening steam valve is closed, and by opening the discharge valve *C*, the steam and water are allowed to blow from the apparatus. Water at a temperature of 75 deg. is then passed through the glass until it becomes cool, whereupon the operations are repeated. To prevent the operator from being injured by flying particles of glass, a wire screen and a sheet-metal guard are placed around the apparatus during the test.

Glasses are considered as suitable for use with high pressure when the average number of operations withstood by three glasses from each lot subjected to the steam shock test is not less than ten. No sample is subjected to the test for more than 15 operations. For example, shipment of glasses is considered as satisfactory if, when subjected to the "Steam Shock Test," three samples break as follows:

	Operations
First glass withstood	15
Second glass withstood	9
Third glass withstood	7
Average	10⅓

Samples of twelve brands were tested according to the steam-shock test, and other glasses of the same brands were subjected to endurance tests under service conditions. The glasses were rated in the following orders of merit from the results of the tests:

Designation of Brand	Merit Order, Based on Steam Shock Test	Merit Order, Based on Endurance Test
Fs	1	2
C	2	1
F	2	7
N	2	6
M	3	3
C	4	4
A	5	5
L	6	8
D	7	10
B	8	9
O	9	12
H	10	11

By the use of the shock test we obtain in a few hours practically the same information concerning the suitability of gage glasses, that previously was possible only after service tests extending over months.

Many steam engines have an inclosed or circulating oiling system for the lubrication of the crank and crosshead pins as well as the shaft bearings. If a bulkhead is not placed between the engine frame and cylinder, water or condensed steam will be carried into the crankcase by the piston rod and the water will soon mix with the crankcase oil. While not so dangerous as in case of the turbine, emulsions should be avoided in all steam engines having a splash oiling system or a circulating oiling system. The correct way to prevent emulsions is to eliminate all chance for water to enter the oiling system. In addition the oil should be thoroughly filtered to remove all free carbon and dirt.

In the ordinary practice of heating buildings by direct radiation the quantity of heat given off by the radiators or steam pipes will vary from 1¾ to 3 heat units per hour per square foot of radiating surface for each degree of difference in temperature; an average of from 2 to 2¼ is a fair estimate. If the temperature in the room is to be maintained at 70 deg., while the temperature of the steam is 220 deg., the emission of heat will be 300 heat units per hour per square foot, equal to about 3 lb. of steam condensed per hour per square foot of radiating surface.

*Chief Chemist, U. S. Naval Engineering Experimental Station, Annapolis, Md.

Did Not Inspect Its Own Boiler

THE report of the explosion of a boiler in the power plant at the Capitol building at Harrisburg, Pa., with the resulting death of two men, is a matter of particular concern to those who are interested in the prevention of these industrial accidents.

The State of Pennsylvania has a particularly active Division of Safety under the Department of Labor and Industry, with a statutory requirement that all boilers shall be inspected periodically. No boiler that does not comply with the standard of the Department, virtually the Code of the American Society of Mechanical Engineers, may be installed, and all boilers are subject to periodical inspection.

These are the provisions that engineers have for years been urging as preventive of boiler explosions, and it is disquieting and incitative of doubt in the system advocated, that a boiler belonging to a Commonwealth that had adopted this program, subject to inspection by its own officers, should explode in its own capitol building.

It appears that the accident was not a true explosion, but the bursting of a tube in the lower row of a water-tube boiler. The boiler was installed in May and had not been inspected or cleaned internally since. Accumulation of scale in the tube is said to be responsible for its overheating and opening for about eighteen inches. The fireman was working upon the fire at the time and with a companion got the full force of the released flood of steam and hot water.

The chief engineer and the chief of the boiler inspection service of the Department of Labor and Industry have been discharged by Governor Pinchot for inexcusable negligence in not having one of the state's own boilers inspected as is required by its own statutes.

Low-Temperature Carbonization

THERE appears sound reason for the belief that the next few years will witness marked activity and far-reaching developments in the application of low-temperature carbonization processes in this country. In the face of new economic conditions pertaining to fuel supply and utilization, many studies have been made and much experimentation has been quietly going on with a view of adapting such processes to American conditions as successfully as they have been applied abroad. In addition to the three or four experimental plants now in operation there are an equal number that may be said to have attained a semi-commercial stage.

Among those who have studied the problem there is sharp division of opinion as to the merits of low-temperature carbonization, especially from a commercial viewpoint. Its opponents as well as its adherents include engineers whose opinions carry weight.

In the leading article of this issue and one to follow next week, Mr. Brooks presents an excellent case for low-temperature carbonization and advances certain suggestions that appear to circumvent many of the usual objections. His figures as presented in the second article are most attractive. That some will take issue with his contentions is to be expected, and it is certain that the author will welcome constructive criticism. The subject is too important to remain buried in reports.

In support of Mr. Brooks' suggestions it will be recalled that one large central-station company, which now burns pulverized coal, has been experimenting for a year or more with such a process and some others, in laying out new generating stations, have taken into account the possibility of coal-treating plants as adjuncts at some later date.

Is it not possible that the history of powdered coal may be repeated, just as soon as the necessary leadership has been established?

Not the Cost of Power But Its Application

SINCE William Green became president of the American Federation of Labor, he has shown an unusual grasp of the situation with respect to the wages of the workers and the cost of production. Many of the things he has said can well be accepted as sound economically. At the recent convention of the Federation there was evidence of a new era in the appreciation of labor toward the economics of American industry. Some of his statements are certainly encouraging and show a vast change from the attitude of reduced production per worker so that more jobs may be created, that is now heard so much about in England.

The recommendations for co-operation between labor and management in industry, so that waste in production may be eliminated, selling prices reduced and wages increased, are sound business economics, and show a thinking that takes into account the fact that before wages can continue to be paid they must be earned. But when President Green says: "We are on the threshold of a new era. We are in the infancy of Giant Power," and sees water-power developments as having a far-reaching effect on industry, he apparently is influenced by what he has seen power accomplish in industry, without taking into account the small part of the total cost of production that power represents. A greater use of power in industry to make the efforts of labor more productive will have its effects in reducing costs and improving the social and economic position of the worker. It is because we excel the rest of the world in making labor more productive by the use of labor-saving machinery that the American worker's standards of living are superior to those in any other country.

Of the costs added by manufacture to the total value

of products produced in this country, wages paid to workers represent about forty per cent, whereas the cost for power is less than three per cent. In such industries as clothing manufacturing, the cost of power is less than one-half of one per cent and wages are about forty per cent. Therefore, anything that might affect the cost of power is not going to change the cost of production in most industries very much. One of the things that will, however, is the greater use of power to make the efforts of the wage earner more productive and more valuable.

Assuming that the physical effort of the average worker is equivalent to one-tenth of a horsepower and that the worker is paid the low wage of seventy-five cents per hour, a cost per horsepower-hour of seven and one-half dollars is obtained. Taking the average cost of power at two and one-half cents per horsepower-hour, the relation of cost between human and mechanical effort is a ratio of three hundred to one. This gives a fair picture of the relation between the wages paid to American workers, with the vast power-driven machinery at their command, and the Chinese coolie, who works with his physical strength unaided.

These figures do not show that the American worker is paid too little or too much, but they do indicate the importance of power as a factor in increasing his productive capacity and reducing the cost of production. They also indicate that the future of the American industry is not dependent upon the cost of power so much as on its utilization.

Boiler-Explosion Statistics

IN A recent editorial discussing the proposed Factory Act *Engineering* says: "In America a single company reported 753 boiler explosions within the last three years. Our own yearly average is 33."

The most complete records of accidents to boilers in America are reported by the Hartford Steam Boiler Inspection & Insurance Company in its *Locomotive*. The total number of explosions reported by it for the year 1922 (three years ago, not the last three years) was 753.

These lists are made up of items, knowledge of which comes to the Hartford company through reports of its inspectors, correspondence, press clipping bureau returns, etc. It is obviously incomplete, but includes many accidents that would not be considered in Great Britain as boiler explosions.

In Great Britain every true boiler explosion, whether it involves loss of life or not, is investigated by the Board of Trade. Real explosions thus become matters of record, and it is possible to have an official statement of the number of such real explosions occurring in any year.

In America no official investigation of an explosion is required except the coroner's inquiry in cases of fatality; and the coroner's job is to find out what caused the death rather than what caused the boiler explosion.

Twenty-one of the forty-eight states of the Union have boiler inspection departments. It should be the duty of such departments to keep records of all boilers installed in their respective states. These records should take account of boilers dismounted and dismantled as well as those newly installed so that they would collectively be a correct statement of the boilers installed and in use, or available for immediate use.

It should also be a function of these departments to investigate any major boiler accident occurring in their respective states, and the duty of the owner or user of any boiler to which such an accident may occur to report it to the Boiler Inspection Department for such investigation.

If the remainder of the states could be persuaded to institute such boiler-inspection departments, we should have, as soon as they all got organized, a complete and official census and record of the installed boiler capacity of the country and, as they reported upon accidents, a record of all major explosions. We should then be able to compare our record of explosions with those of other countries and to present our case in terms of real explosions per thousand of boilers in use. Without some similarity of understanding of the meaning of "explosion" and without some consideration of the total numbers of boilers involved, such figures as those quoted by our contemporary are useless for comparison.

Men and Shovels

THE shovel, though obsolescent, is not yet obsolete. Replaced for most big work by the steam shovel and drag scraper of the contractor and the mechanical stoker of the power-plant engineer, it still hangs on more or less tenaciously for the odd jobs of the former and the small plants of the latter. Often, it is true, plants are handfired long after reaching a point where stokers would be economically justified. But, whether the retention of handfiring is wise or otherwise, failure to take full advantage of existing possibilities can hardly be pardoned.

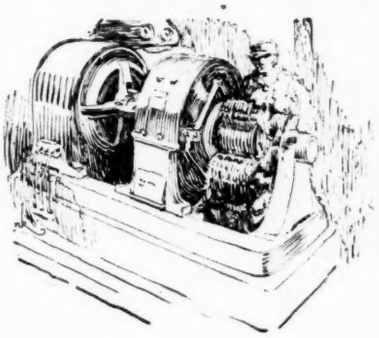
With a passable setup in the way of boiler, furnace, grate, fuel, draft, etc., fairly good efficiencies *can* be obtained with hand firing. Unfortunately, they rarely are obtained. The notion still persists with the management, and sometimes with the engineer himself, that the boilers will consume a certain amount of coal anyway, so that it is enough to hire the cheapest man who can feed the brute. The mere ability to shovel coal may fit a man for yard work or cleaning out coal cars, but it is hardly a sufficient qualification for a fireman. Both in pay and considerations firemen should be rated well above so-called "common labor." Their job involves responsibility for the expenditure of considerable sums of money and demands a high degree of intelligent loyalty. These qualifications must be paid for, particularly since the work itself, being dirty and laborious, is generally looked down upon by those who do not understand it.

But even good pay and careful selection will not work miracles unless reinforced by intelligent control and instruction of the firing force. The engineer or boiler-room foreman must find out for himself the best way to handle the fires in his plant and then secure the active co-operation of the firemen in carrying out instructions.

There are still many plants where intelligent firing would reduce the coal bill at least ten per cent.

The World War began in 1914. A Mollier Diagram copyrighted in that year stops at two hundred and fifty pounds pressure. Presumably the authors thought that the extreme limit of practice, although available steam tables ran to six hundred pounds. "The world do move!"

Practical Ideas from Practical Men



WITH a view to stimulating engineers into the habit of recording for the benefit of brother engineers, unusual occurrences, how these were met and other practical expedients adopted in the operation of their plants, Power has decided to award two cash prizes each month during 1925. One of $25 for the best and another of $15 for the second best practical letter on plant operation or practical kinks received during the month. This is in addition to payment for the contribution at space rates. The winners for September will be announced next month.

How Belt Slippage Was Overcome

In our plant we have a 14-in. 7-ply belt driving an air compressor. The driving pulley on the lineshaft is 36 in. in diameter and is equipped with a friction clutch. The cast-iron pulley on the compressor is 54 in. in diameter and the distance between pulley centers is approximately 16 ft. This compressor is operated about 18 hours a day.

Some time ago we had trouble in keeping the belt from slipping. It would run all right for an hour or two after starting up and would then begin to slip. We consulted different engineers as to the best way of overcoming our trouble, and each one recommended lagging the pulley with leather or wooden cleats; but owing to the thickness of the rim we considered this would be too big a job. We finally decided to try painting the surface of the pulley, and this proved satisfactory.

The face of the pulley was washed with gasoline, then with muriatic acid, sufficient time being allowed for the acid to penetrate and cause a coating of rust. In three or four hours after the acid had been put on, we applied a coat of white-lead paint. When this was thoroughly dry, a coat of varnish was put on. This was followed with two additional coats of varnish, sufficient time being allowed between the coats to dry thoroughly. When the last coat was perfectly dry, the belt was put on, and we have had no further trouble with belt slipping. C. L. SELBY.

Saint Marys, Ohio.

Conditions Not Uncommon in the Power Plant

I was in a certain power plant some time ago making an inspection. It was a well-run plant and in many respects a model. I wanted, for purposes of my own, to take a picture of the turbine floor, and the only place I could get the view I wanted was from the top of the main header at the end of the building. So, getting a ladder, I went up, but I could not remain there long owing to the heat radiated from the pipe.

I have visited several power plants and have noticed the same condition. There are many hot corners due to uninsulated piping. Now if the pipes in these places were insulated, there would be a material saving of steam. The mistake is often made of figuring the loss of heat due to bare pipes on the cost basis instead of what the saving would return on the money invested. Many times I have seen uninsulated steam pipes next to an open monitor and as close to cold air as they could be. Then again the hot air from the generators is allowed to go out through the monitors in the roof. If building heating is needed, why not put in low-pressure steam heating that can be regulated instead of wasting so much from the turbine shells and pipes because not enough insulation was used? I know of four cases of insulating the same size of turbines operating with approximately the same steam conditions where there were four different thicknesses of insulation used and all four jobs were done by the same company.

Heat insulation is for the purpose of conserving heat, and when it fails in that, it is a poor ornament, for much nicer looking coverings can be bought for less money. W. ASPRIL.

Norfolk, Va.

The Flush-Front vs. the Extension-Front Boiler

In most plants using horizontal return-tubular boilers we find the flush-front type, and invariably when the owner is asked *why*, he will say "because it looks better" —but why do we lay so much stress on looks when efficiency should be the first consideration? It has been my experience that few flush-front boilers have tight doors on the smokebox and that it is difficult to keep the bricks in place at the end of the boiler and at the breeching connection.

In my opinion the extension-front boiler is much superior to the flush front, in that the smokebox is bolted to the boiler, and where sheet metal is used for the front and doors, a tight job is secured, which does not allow the leaks usually encountered with the flush front type. Also, the arches over the firing doors can be made shorter or just thick enough to protect the metal, which gives the fireman a better chance to handle his fire in the front corners.

Again, some engineers and firemen seem to believe that building a large pillar of brick around the blowoff will protect it from the heat. In some cases these are built so wide that they cut off about one-third of the gas passage and restrict the gas flow through the central tubes of the boiler. A remedy for this condition is to place the protector six inches or so in the front of the pipe and make it a two-brick triangle. This form gives ample protection to the pipe and offers little restriction to the flow of the gases. L. L. SCHEIDERER.

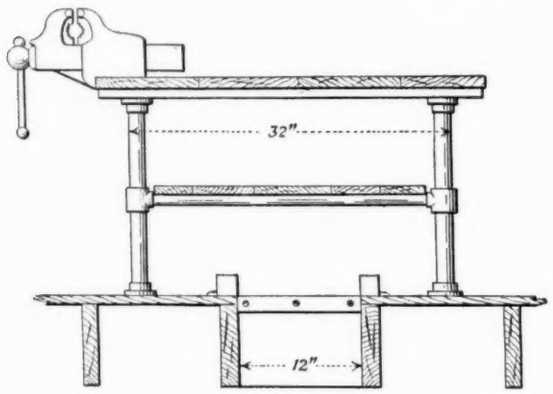
Toledo, Ohio.

A Neat Arrangement for the Steamfitter

Adjoining the engine room in a large textile mill there is a room 20x40 ft. that is used by the steamfitters. A couple of pipe machines are at one end, a good-sized work bench is built along one wall, and the opposite wall is pretty well covered with stock bins containing a complete set of fittings for everything in the mill from the main steam log down to the glue heater in the carpenter's room.

That part of the bench devoted to pipe work is built with a sloping top, the rear of the bench being about one inch lower than the front. This is a simple thing to do, but it saves the endless stooping over to pick up nipples and fittings that have rolled off.

But what strikes the visitor most forcibly about the room is the single bench about 3x8 ft. in the center of



Opening in floor below bench takes the place of the usual trap door

the room, entirely surrounded by space. Now, every plumber and every engineer who has to do the factory's pipefitting knows the value of space in which to swing lengths of pipe, but few of them have the temerity to ask for a room in which there is that kind of space, and fewer yet would know offhand how to arrange for that space if they had it. The arrangement here described may well be taken as a model by others.

This bench is framed of 2-in. pipe securely fastened to the floor and has a top of maple $1\frac{3}{4}$ in. thick with a lighter shelf underneath. A rugged combination vise is part of the outfit.

The most unique part of the arrangement, however, is the hole under the bench. This is the length of the bench and the full width between two floor beams. Its purpose is to provide an opening through which pipe may be handled from the storage room below. The storage space is a low, dark room with an outside entrance for trucking, and in it all pipe is stored. It is an ideal place for such storage, when so accessible to the workroom, and avoids blocking the latter with pipe racks and piles of short pieces as is so often the case.

With this floor opening, pipes are passed either way just as readily as if valuable floor space were taken for the usual big trapdoor. There is no delay with this method and no danger from an open trapdoor.

At the ends of the opening, sections of steel angles are set in flush with the floor as protectors, and the sides are also faced with angles for a similar reason. But on the sides, the angles are set above the floor; this keeps pipe and fittings from rolling into the opening and it serves as a guide to the hole when a man stands at some distance with a long piece of pipe that he wishes to pass down to the cellar.

The arrangement is as inexpensive as any other to install, and it has many advantages over the usual claptrap one with attendant inefficiency and risks. Also it is as valuable in a one-man shop as where a gang of fitters are kept busy all the time.

Middletown, N. Y. DONALD A. HAMPSON.

A Hydraulic Pump Used to Boost Steam Pressure

During the last few years we have found it necessary to test quite a number of high-pressure steam fittings with live steam. The maximum pressure in the steam lines throughout the plant has been 150 lb., while some of these fittings require a test at 300 or less but more than 150.

The number of such tests was never great enough to justify the installation of a high-pressure boiler, since such an installation would be expensive unless made on the test floor, and even then it would run into considerable money.

We had a 9x4x10-in. hydraulic test pump already installed in a position convenient to the test table, and struck upon the plan of using it to boost the steam pressure to the desired point, since it was never used for the purpose for which it was originally set up.

It had a piston with rings in the liquid end. The greatest objection to using it as it stood was the fact that it had a clearance volume too great for the effective compression of gases beyond a given point. We built up the piston and reduced this volume, then piped steam to the former liquid inlet and put lubricators in this line and on the packing glands. An abundance of oil was used because the steam was not to be condensed and used over again. The original valves for liquid were left in the pump without alteration.

The line pressure of 150 lb. was easily boosted to any desired pressure, but we found that the capacity was so limited that in testing large castings the condensation was so great that the capacity of the pump was seriously taxed.

Then we struck upon the plan of superheating the steam after it left the booster and before it was introduced to the piece to be tested. A piece of 1-in. pipe was wound into a coil 12 in. in diameter and joined to a second similar coil which gave ten complete spirals.

This coil was placed in the steam delivery line, and a firebrick box was built around it. Then a gas burner, using city gas, was installed to throw a flame through this box and heat the coil and superheat the steam.

Thereafter it only became necessary to use the superheater in order to test the larger valves and castings.

Nothing can be said in favor of the economy of operating this combination except that it has saved the cost of installing considerably more expensive equipment. No doubt we would obtain much better results if the valves of the booster were altered to something resembling air-compressor valves and thus reduce the losses through back leakage, and also fit up for oil burning in place of using gas for superheating. However, the owners of the plant do not feel that this is necessary since the need of high-pressure steam does not often arise and the volume required is never great.

Woodbury, N. J. A. B. NEWELL.

Comments from Readers

Utilizing Waste Firebrick

I was much interested in the letters by J. A. Faulkner and H. E. Martin in the June 16 and July 7 issues respectively, commenting on my letter in the April 21 issue on "Utilizing Waste Firebrick." Mr. Faulkner recommends the use of the waste brick and offers to give facts and figures to prove it is of advantage to make use of the old brickbats. He, no doubt, has all the necessary data at hand to make a good mixture of fireclay, cement and ground brick, etc., and can also advise what machines are necessary to install a refractory material plant, but this does not prove that it is advantageous for every engineer to undertake the manufacture of his own material.

In my opinion Mr. Martin strikes the nail on the head when he states: "A plant trying to make its own patching material or refractory cement is trying to compete, in a slipshod way, with manufacturers who have spent large sums of money in research, etc." No definite advantage can be obtained by any engineer attempting to manufacture refractory material. The principle of the thing is wrong, therefore the results, however good at times, cannot be satisfactory. The engineer who is bothering his brains about making refractory material or any other material that can be obtained from reliable concerns that have given years of study to the subject and that are still striving to reach perfection, is miles behind the times. The time the engineer is wasting, is to the detriment of his plant in general, because the time can be far better employed in other directions and not sacrificed in investigating or attempting to imitate something the specialist has already produced and placed on the market in the most convenient form to suit the engineer's requirements.

We all know engineers who have their little hobbies. In fact, here in South America, not far from Buenos Aires, there is an engineer who has been working on new mixtures of refractory material, but admits he has not got his "refractory mud" quite good enough yet. When it was suggested to him that he might do better for his plant, by bothering less about refractory material and more about the output of his factory, he argued he was working to obtain cheaper upkeep, being of the opinion that every cent spent on material only added to the overhead charges. JAMES JOHNSTON.

Buenos Aires, Argentina.

Construction and Use of the Thermocouple

On page 378 of the Sept. 8 issue there appears a letter by Richard H. Morris, entitled, "Construction and Use of the Thermocouple." This letter is in the form of a comment on the article by C. E. Colborn in the June 2 issue. Mr. Morris contributes some interesting and valuable information with which I am in full agreement, and I am glad to see it brought to the attention of *Power* readers. However, he is apparently not familiar with the industrial types of potentiometer which are giving, and have given for a number of years, thoroughly satisfactory service under severe plant conditions.

As a matter of fact, with the development of the industrial potentiometer, in the indicating, recording and controlling forms, the application of potentiometers to temperature measurements using thermocouples has increased to the extent that there are probably far more industrial potentiometers in use than there are laboratory potentiometers. Consequently, while the potentiometer was originally a laboratory instrument and designed for laboratory use, it is now distinctly a plant and shop instrument, there being types available for practically every industrial use.

When it is considered that industrial-type potentiometers are available and can be used for the measurements outlined by Mr. Morris, the man who contemplates making such measurements need give no thought to the errors arising from lead and contact resistances regardless of the temperature of the leads, because when using a potentiometer the resistance in the thermocouple circuit cannot possibly cause an error in the measurements.

In the discussion of cold-junction compensation Mr. Morris states that the bimetallic spring is the most successful means for taking care of the cold-junction temperature. While this may be true if millivoltmeter-type pyrometers are being considered, it is certainly not true so far as the potentiometer is concerned. When the industrial potentiometer is designed for temperature measurements with thermocouples, the cold-junction temperature is compensated for automatically by interposing in the circuit of the potentiometer a resistance coil having a comparatively large temperature coefficient of resistance. The coil is usually made of nickel. The temperature coefficient of the material used is accurately known, and when once adjusted, the cold junction compensation is permanent.

Philadelphia, Pa. I. MELVILLE STEIN,
Leeds & Northrup Co.

Does Extra Heating Surface Pay?

In the issue of Aug. 25 there is an editorial entitled, "Does Extra Heating Surface Pay?" The writer of the article practically states that on account of the recent reduction in the sizes of plates, boiler sizes are limited to 72 in. Now there has been no reduction of sizes. On the contrary there has been an increase, and plates can be obtained so large that a good-sized boiler can be made of a single plate. Plates can be rolled so wide that a head for a Scotch marine boiler, 15 ft. 3 in. in diameter can be made in one piece without welding a piece on the edge to permit flanging, the flanges being 11 in. wide. The mill is 206 in. between housings, and heads even larger than the one mentioned can be made.

The statement is made that tube lengths have been

reduced. In fact, 3-in. tubes 30 ft. long can be obtained.

With regard to the sizes of horizontal return-tubular boilers, I have been informed that they have been made up to 120 in. in diameter. I know of one or more 108 in. in diameter and many 90 in. in diameter. Some of the latter have over 4,000 sq.ft. of heating surface and are worked up to 200 and 300 per cent of normal rating. These boilers have 260 three-inch tubes 20 ft. long.

The editorial states that the size and number of tubes are doubtful, and mentions 110 three-inch tubes in a 72-in. boiler. I always use 140 three-inch tubes in a 72-in. boiler and have heard of no objection to it. I do not believe in wasting space in boiler rooms and believe in getting all of the capacity possible in each boiler.

The editorial also states that perhaps the upper row of tubes takes most of the gases. The distance from the bridge wall to the uptake through any tube is the same, the resistance is the same, and why, therefore, should most of the gases flow through the upper row of tubes?

In a boiler the smallest practicable size of tubes should be used, and 3 in. for a horizontal return-tubular boiler is none too small. It is important to split the gases into small streams to bring them into close contact with the heating surface so that the heat will be readily absorbed. The smaller the tubes the less the gases passed through any tube or group of tubes. The Serve ribbed tube proved the value of splitting up the gases.

The editorial seems to imply that there is no use in having more than a certain number of tubes, but how is a big boiler to be made if not by increasing the number? I know of no evidence, as the article states, that the greater part of the gases pass through the upper row of tubes, and as for circulation in a horizontal return-tubular boiler there is no evidence that it is not ample.

F. W. DEAN.

Boston, Mass.

The Welding and Cutting Torch in the Power Plant

I was much interested in the letter by L. A. Cowles in the July 21 issue on "The Welding and Cutting Torch in the Power Plant," as I have had considerable experience during the last few years with the torch, on both production and repair work in power plants.

It is well known that welding, as practiced today, has passed beyond the experimental stage and has become a reliable method of performing certain operations in the reconditioning of power-plant machinery and mechanical devices. Employed under proper conditions, by one qualified to undertake the work, welding may be relied upon to make good on practically any job whether the material involved be cast iron, wrought iron, cast steel, alloy steel, aluminum, brass, bronze, copper, monel metal or gun metal. Welds made by the oxyacetylene process, possess a degree of strength only slightly below that of the original section, and by reinforcing, this can be increased to any desired amount.

To weld properly and to make joints sound throughout, skill and training are required, together with knowledge how to apply the system as well as how to design and prepare the work for being welded. Stresses are unavoidable, but their effect can be minimized or nullified by properly designing the shape of the article to be welded. For example, a steel boss had been welded into the center of a flat circular mild-steel plate ⅝ in. thick, with the result that in cooling, radial cracks appeared. If the same plate had been dished or curved and of good soft quality, it would have yielded to the stresses and would have been free from fracture or the risk of it.

The advantage of this kind of welding is that, unlike the ordinary blacksmith's work, it is possible to be sure of a sound homogeneous weld. The weld is built up from its foundation, and in most cases can be watched and its soundness and strength insured, provided of course that it is properly and intelligently done. It is sometimes argued that in gas welding the result depends on the individuality of the workman. To a certain extent this is true, as it is true of most mechanical operations. In a weld, however, there is this difference from some other kinds of mechanical work, that a defect is not always apparent. With proper training and adequate supervision, however, and a suitable test there is no reason at all why confidence should not be felt to much greater extent in gas welding than in ordinary forge welding.

During the last month in our power plant a cast-steel gear wheel was badly damaged, three of six spokes were broken, two entirely out, and five gear teeth were broken. The wheel was 5 ft. 6 in. in diameter and weighed about 700 lb. Scrapping it meant the purchase of a new wheel from the manufacturers, involving perhaps a long delay in getting one cast and machined. But with the welding torch the fractured spokes were welded into place and a fourth spoke broken near the hub, was also welded. The new teeth were built up by inserting a carbon block at each side of the tooth to be repaired, and filling up the spaces with molten metal. Care had to be taken in preheating so as not to crack the rim, and also to prevent the welded teeth from cracking by cooling down too quickly. To assure the knitting of the teeth to the gear rim, the torch flame must play into the cavity until the rim metal fuses a little, after which fill in with the welding rod, leaving a little surplus metal to be dressed off the top. The job was done economically at a cost of $20, ready to be put in service in twelve hours from the time of fracture, which was considerably better than buying a new wheel and waiting a couple of weeks for delivery. In many cases the actual cost of making the weld is not the most important feature. Generally, it is the time element that counts in power-plant installations and industrial establishments, especially where the replacement of a gear wheel would entail a long delay or shutdown.

It may be safely stated that one of the principal qualifications in the art of welding by the oxyacetylene process is ingenuity. The welding operator should never admit to himself the impossibility of any job. It is true that some operators become more proficient in the art in a shorter time than others; but even with every facility at hand the use of the welding torch is not all that is required—much experience is needed to become an all-around welder. I have observed on several occasions that the average operator requires at least one year in a good welding plant before he is competent to weld the various jobs that are brought before him. It is not necessary for an operator to follow any special trade in order to become a good welder, but some knowledge of several trades is necessary, and the more known about them the better.

The training that the power-plant mechanic or machinist-engineer receives particularly fits him for this work. While working at his profession he has to handle all kinds of metals. Consequently, he learns the properties and characteristics of most metals, and from experience can tell what the metal is as soon as he looks at it. Again, he learns how the different metals behave under strains and stresses, and of the best metal to withstand certain strains, heat, etc. Therefore when a welding repair job urgently crops up, he is familiar with conditions and knows what treatment to give the weld. Unskilled workers, however, with perseverance, skill and training under a competent welder, accompanied by a fair amount of study, make good welders. E. ANDREWS.

Manchester, Eng.

College Entrance Requirements for Engineering Students

A reading of the excellent article entitled "College Entrance Requirements for Engineering Students" in the Aug. 4 issue suggests that it might be advisable to go farther back and consider some possible sources of weakness in the system of preparing the student for the college-entrance examinations. There are two such sources that might be called general. Of course, much depends upon the individual instructor, but that point will not be considered in this article. Again, the textbooks used play an important part. The mathematical subjects studied, as algebra, geometry and trigonometry, and the principal sciences, as physics and chemistry, are unchangeable in that they are founded on fixed laws and rules that are fundamental and that were discovered generations and even centuries ago. This perhaps is not wholly true of physics and chemistry in one sense, because in some lines these subjects are so rapidly developing that new discoveries serve to make the teachings of yesterday obsolete. Particularly is this true as to the theories of atoms and the chemistry of the radio-active elements. Thus while the textbooks of earlier years will answer for the mathematical subjects, for the teaching of the sciences it is advisable that the books be the most recent and at the same time the best obtainable.

One main source of weakness in many of our high schools today is that the lessons assigned each day are not long enough. The pupil should be given more pages of text for each day's work, or more problems should be given for solution. This can be readily proved by comparing a day's work as given in the average high school with that given in a real college preparatory school such as Andover, Exeter and similar places. Many a student going from a high school to one of these preparatory schools for a final year before entering college, has been shocked by the length of the lessons assigned. They have been known to remark that they never were obliged to do real studying before, and that they had never been given real lessons in the high-school days as compared with the ones they were then receiving, although at the time they thought they were being overworked.

There is some excuse perhaps for this laxity on the part of the high-school teachers. In the college preparatory schools every pupil is planning to go to some higher institution of learning, and therefore all must have the same degree of instruction. The lessons must measure up to the one high standard necessary to prepare the pupil properly. In the high school, on the other hand, the majority of the students will go no farther, and thus there is not the necessity of covering the extensive ground and requiring the large amount of studying. In fact, it probably would be unwise to do this, since the tasks would be too severe for the general run of the students. There would be but few who would pass. It is therefore left to the individual student himself to cover voluntarily the additional ground required, and to do this faithful intensive work that is necessary. Students have often gone into "exams" and found questions on work that had not been reached by them in their high-school classes.

The second source of weakness is this: In many high schools those pupils whose daily work averages are above 90 per cent are not required to take the midyear and final examinations. Now while this exemption acts as an incentive to the student to keep up his daily work and may be considered as a worthy reward, yet when it is applied to students planning to take college-entrance examinations, the idea is absolutely wrong.

Hundreds of bright capable scholars with high averages and with real knowledge of the subjects involved have gone into the examination rooms and flunked, simply because they had not had training and experience in taking real examinations. They did not know how to go at the task. Possibly some had stage fright at the start and quickly forgot all that they knew. The inexperienced pupil will begin with the first question and will proceed in regular order. If the second or third question for instance is difficult, he will continue to work on that one, meanwhile becoming more scared and nervous, and after a disproportionately long time may have to give it up altogether. By this time he is a nervous wreck, and succeeding questions that at the beginning he could have answered quickly will now appear most difficult if not impossible to answer. Not half of the list of questions has been covered, and the examiner has no alternative but to mark the paper as a failure.

How is it with the student who has been accustomed to taking examinations? He quickly looks over the questions, selects those that he can readily answer and does so. This done, he takes up the consideration of those that demand more thought and time. His mind is still as clear and his mental state as calm as at the beginning. The three-hour "exam" of the college board is a man-sized piece of work, and the more familiar a student is with such in the high-school classroom, the better will he be able to do justice to it and to himself. This is particularly true of those subjects in which applicants for admission to engineering colleges are examined, such as mathematical subjects and physics.

Many high-school principals have come to recognize this weakness in their school system and now require that all students who are preparing for college take the examinations regardless of their term averages. They also use for the examination questions those given by the college board in previous years. This is an excellent plan and is a great help to the student. If the records of students from such schools were followed up, it would undoubtedly be found that they made better showings with the college-entrance requirements than an equal number of students trained otherwise, and it might also be found that their subsequent work during the four years of college work would show similar differences. A. J. CALHOUN.

Lawrence, Mass.

Questions and Answers

Conducted by

Franklin Van Winkle

Quantity of Ammonia in Refrigerating System and Time for Blowing Off Oil Trap

How can an idea be obtained of the amount of ammonia there is in an ammonia refrigeration system, and whether there is enough or too much in case there is no gage glass on the receiver? Also, when is the best time to blow off the oil trap, after a period of shutdown or when running? *C. F.*

As long as the suction line is frosted up to the machine, one may be confident that enough liquid is reaching the evaporating coils. This is the part where the liquid is needed, and as long as this condition prevails there is ample liquid. Of course the receiver should be partly filled, to act as a reserve supply in case the refrigerating duty must be unexpectedly increased. When the oil trap is not completely blown down, it is best to blow it off when the plant is shut down.

Heating Water of Swimming Pool

We warm the water of an indoor swimming pool by direct injection of live steam that is delivered through perforated pipes in the pool. Could not the heating be performed more economically by having coils in the pool with return of the condensate to the boiler? *R. R. K.*

Direct injection of the steam and mingling of the condensate with the water of the pool is the most economical method that can be practiced, as all heat contained in the steam then is delivered down to the temperature of the water in the pool. The main advantage of heating the water by steam coils would be to prevent the discharge of the condensate into the pool. The steam then would part with only its latent heat, more steam would have to be handled, and there would necessarily be some loss of heat in the operation of returning the condensate to the boiler, and under ordinary conditions the loss would amount to more than supplying the boiler with raw feed water.

Checking Location of Water-Gage Glass of Vertical Fire-Tube Boiler

How can a check be made of the proper height for the water-gage glass of a vertical fire-tube boiler? *S. M.*

The lowest visible part of the water-gage glass should be not less than 2 in. above the lowest permissible water level, and the lowest permissible water level for an ordinary vertical fire-tube boiler should be at the same height as required for location of a fusible plug, which should be placed in an outside tube, not less than one-third the length of the tube above the lower tube sheet. Locate the height of the lower tube sheet on the side of the boiler shell, preferably by taking the same distance below the lower side of the handhole for washing the tube sheet that the tube sheet is below this handhole. Then the height for the lowest visible part of the water-gage glass should be above this mark a distance equal to one-third of the distance from the mark to the top of the upper tube sheet, plus 2 in. But if the boiler is of the vertical submerged-tube type, the position for the fusible plug would be in the upper tube sheet, and the level for the lowest visible part of the water-gage glass then should be 2 in. above the upper tube sheet.

Indicator Diagram Showing Lower Initial Pressure for Head End

What may be causes for a lower initial pressure line on the head-end indicator diagram of a Corliss engine than the initial pressure line of the crank-end diagram? *R. E. B.*

When diagrams are taken nearly simultaneously with the same indicator, indication of less initial pressure by the diagrams from the head end, for the same position of the throttle valve, would be caused by slower opening of the steam valve, contracted steam ports and steam passages, leakage of exhaust valve on the same end of the cylinder, and leakage of the indicator cock or indicator connections. Another contributing cause, but probably of small effect, would be higher velocity of the engine piston in the head end of the stroke than in the crank end, due to angularity of the connecting rod, but with the same valve action and same dimensions of steam ports and passages in each end of the cylinder this effect would be hardly noticeable with the ratio of connecting rod to length of crank generally used on Corliss engines.

Lower initial pressure also might be shown from preventing the full rise of the indicator pencil motion from pressing the pencil motion with more force than necessary for obtaining a light line on the paper, or from a paper drum being bulged out of true circular form, or sticking of the indicator piston. If the valve setting is the same for each end of the cylinder and ports and passages are apparently the same and less compression is shown for the head end, examine the head-end exhaust valve for leakage as the cause for lower initial pressure.

Required Size for Through Stay

In a horizontal return-tubular boiler the area of the segment of heads supported by braces is 4 sq.ft. There are five straight rods from head to head so placed that each carries the same load. The greatest boiler pressure is 125 lb. per sq.in. What should be the diameter of the braces? *J. T.*

As the area supported is 4 sq.ft. or $4 \times 144 = 576$ sq.in., each of the through braces would support $(576 \times 125) \div 5 = 14{,}400$ lb.

For unwelded stays and unwelded portions of welded stays the allowable tensile stress for the material would

be 9,500 lb. per sq.in., assuming that the ultimate tensile strength of the material is 50,000 to 55,000 lb. per sq.in.

Hence, the least cross-sectional area of each stay should be 14,400 ÷ 9,500 = 1.5157 sq.in., which corresponds with the area of a circle whose diameter is of $\sqrt{1.5157 \div 0.7854} = \sqrt{1.9298} = 1.386$ in., or about $1\frac{3}{8}$ in. in diameter, which must also be the least diameter at the base of screw threads for upset ends.

If the stays are welded, the allowable tensile stress for the welded portion would be 6,000 lb. per sq.in. of cross-sectional area and then the welded portion should have a cross-sectional area of not less than 14,400 ÷ 6,000 = 2.4 sq.in., corresponding with $1\frac{3}{4}$ in. diameter.

Obtaining the Length of Pump Piston Rods

How can I obtain the correct length of piston rods for a duplex steam pump where steam pistons and water plungers are on hand, but the old rods cannot be referred to? *H. H.*

The best method of determining the required length for a new piston rod for either side of the pump is to make measurement with a wooden rod when each piston stands at the middle of its travel.

In valve setting or other adjustments of the steam end of the pump, the middle of the nominal stroke is assumed to be the middle of the contact or bumping stroke of the steam piston, and the water piston or plunger is supposed to be at the middle of its travel when placed centrally between the water cylinder ports, or when the water cylinder is provided with a liner, when placed at the middle of length of the working bore of the liner.

For placing the steam piston at the middle of its stroke, insert the piston in the cylinder, projecting a short distance beyond the face for receiving the cylinder head, and push the piston to the striking point with the head by temporarily replacing the head; remove the head and mark from the end of a rod the distance, if any, that the lowest part of the piston has been pushed beyond the end facing of the cylinder. Then push the piston hard against the stuffing-box end of the cylinder and measuring between the same points as before, make a similar rod measurement of the distance the piston has been placed beyond the end face of the cylinder.

The midstroke position of the piston can be found by taking one-half of the difference of measurements from the end face that were taken for the extreme positions. It is of course assumed that the cylinder head is provided with a cavity which allows good clearance for the proposed nut and overhanging end of the rod.

For placing the water piston when there is no water cylinder lining, remove the water cylinder head and mark on a gage stick the distance between the ports; from this distance set off the length of the piston or plunger and set the piston at one-half of the difference, measured from the piston to the inside edge of the head endport. Where the cylinder is provided with a liner, take the length of the working bore, from it deduct the length of the piston and place the piston at one-half of this difference from the end of the bore.

Then, with both pistons at mid-stroke, the length for the rod, outside end to outside end of the piston bores, can be obtained on a wooden rod passed through the pistons and stuffing boxes. Having this length with pistons removed for further reference, due allowance can be made for fitting the ends of the new piston rod.

Hoop Stress in Cylindrical Shell

What is meant by hoop stress of a cylindrical boiler shell and how is it used in computing the safe working pressure? *L. G. T.*

The term hoop stress, or hoop tension, in the shell of a cylindrical pressure vessel refers to the tensile stress on the shell material in a circumferential direction, like the stress on the hoop of a barrel.

Referring to Fig. 1, suppose a cylindrical shell of thickness t inches, and internal diameter D inches is 1 in. long and the internal pressure is p pounds per square inch. Neglecting any assistance that may be rendered by the heads or covering of the ends of the shell, the upper half would be held to the lower half by the tensile strength of two diametrically opposite sectional areas like *ghjk*. For any given internal pressure, the total stress to be resisted by the two sectional areas would be the same if the upper half were joined to a solid with a plane face *ABCE*, as shown in Fig. 2, in which case it is evident that the total pressure to be resisted by the tensile strength of the material in the cross-sectional areas *AE* and *BC* would be $D \times 1'' \times p$, or Dp, and for any cross-sectional area like *ghjk*, Fig. 1, where the width of the hoop is 1 in., the tensile stress would be $\frac{1}{2}$ of $D \times p = Rp$.

Where TS is the ultimate tensile strength per square inch of cross-sectional area of the material and the

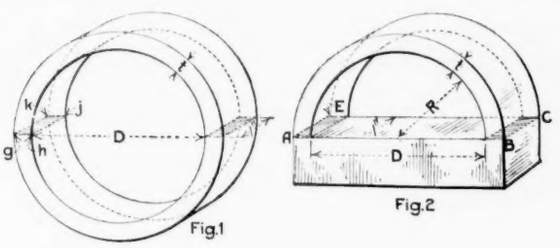


Diagram illustrating solution of hoop stress

actual cross-sectional area of the hoop is $1'' \times t$, the ultimate tensile strength of the hoop would be $(TS \times 1 \times t)$ pounds, and, for equilibrium, there must be the equation, $Rp = TS \times 1 \times t$, or

$$(1)\quad p = \frac{TS \times t}{R}$$

Therefore for the longitudinal joint of cylindrical shell of a boiler or drum, where

p = Maximum allowable pressure, lb. per sq.in.;
TS = Ultimate tensile strength of the material, lb. per sq.in. of cross-sectional areas;
t = Minimum thickness of shell plates, in the weakest course in.;
E = Per cent of efficiency of longitudinal joints, or of a ligament between tube holes (whichever is least);
R = Radius of the weakest course;
FS = Factor of safety,

the formula (1) becomes

$$p = \frac{TS \times t}{R} \times \frac{E}{FS}$$

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communication, and for the inquiries to receive attention.—Editor.]

A new slant on things observed in and out of the power plant

What Happens and Why?

Tide Power

EVERY few years public interest centers on some project for the generation of power from ocean tides. Perhaps the most serious recent proposals have been those covering plants at the River Severn in England, the Aber Vrac'h in France, on the Bay of Fundy at Hopewell, New Brunswick, and now at Eastport, Maine, which also lies on the Bay of Fundy at the Canadian frontier. This latest proposal, known as the Passamaquoddy Tidal Power Project and promoted by Dexter P. Cooper, has recently been sanctioned by popular vote in Maine. The waters involved lying partly in Canada, the project awaits approval of the Canadian, New Brunswick and United States governments, as well as the securing of necessary financial backing.

In spite of their paramount importance there is not space for discussion of the economic aspects of tide power in this brief article, which will be confined to a simple outline of some of the scientific principles involved.

Ocean tides are caused by the attraction of the sun and moon, principally the latter. The moon attracts all parts of the earth, but pulls hardest on the near side and least on the far side. This attraction tends to raise a hump or wave on the water facing the moon and another hump on the opposite side. The latter is due to the body of the earth being more strongly attracted than the water on the far side.

If there were no celestial motions except the rotation of the earth, these two waves would make the circuit of the earth once every 24 hours, giving two complete tide cycles from high to high in that time. But the moon moves slowly around the earth, rising later each night, so that the apparent rotation of the moon around the earth (representing the combined effects of the earth's rotation and the actual movement of the moon around the earth) requires 24 hr. and 50 min. In this period there will be two high tides as the crests of the tidal waves pass the observer and two low tides as the hollows pass him. From one high tide to the next will take about 12¼ hours. (Actually 12 hours and 25 min.), normally divided into 6¼ hours of "flood" (rise) and same duration of "ebb" (fall).

The height of the tide—that is, its rise and fall—varies greatly over the earth's surface. For example, it averages 4.4 ft. at Governor's Island, New York Harbor, whereas the mean tide is 9.6 ft. at the Boston Navy Yard.

Nova Scotia, Canada, is a large peninsula overlapping the whole New Brunswick shore and part of Maine and forming the Bay of Fundy, which is 180 miles long and has an average breadth of 35 miles. Entering the Bay of Fundy along the Maine shore, the tidal rise increases rapidly. At Eastport the mean tide is 18.2 ft., while at Hopewell, N. B., at the head of the bay, the average rise is 38 ft.

The extremely large tides in the Bay of Fundy are due to the piling up of tidal wave between the narrowing shores of the bay. The same effect may be observed when an ordinary wave strikes a funnel-shaped notch in the shore.

The frequent references to "average" or "mean" tides emphasize the fact that the tidal rise and fall at any point varies from day to day. This is due to the fact that the sun produces a secondary tide somewhat smaller than the moon tide. When the sun and moon are together (new moon) or 180 deg. apart (full moon) the two tides add up, giving extreme highs and lows. Such tides are known as "spring" tides.

At the first and third quarters of the moon the two tides oppose each other, giving the low-range "neap" tides. From spring tide to the next neap tide, or the reverse, takes about seven days. At Hopewell the neap tides are about 32 ft., normal tides about 38 ft., and spring tides about 45 ft.

The rise and fall of the tides, when unaffected by the flow of rivers or other disturbing influences, follows what is known in science as a sine curve, an example of which is shown in Fig. 2 (solid line). This represents motion like that of a pendulum—slow near the two extremes and fastest at the middle (that is, at half tide). Note that the tide rises for approximately 6¼ hours and falls for another 6¼ hours, making it about an hour later each day. Thus if we start with dead low tide at midnight the approximate times of high and low tides will be as follows: First day—12 a.m., low tide; 6: 15 a.m., high tide; 12: 30 p.m., low tide; 6: 45 p.m., high tide. Second day—1: 00 a.m., low tide; 7: 15 a.m., high tide; 1: 30 p.m., low tide; 7: 45 p.m., high tide.

Practically all serious schemes for using the tide require the presence of large natural reservoirs connected to the ocean by channels sufficiently narrow and shallow to make possible the construction of dams at reasonable cost. With a single reservoir intermittent power can be obtained by impounding the water at high tide and passing it through a wheel to the ocean after the tide has fallen sufficiently.

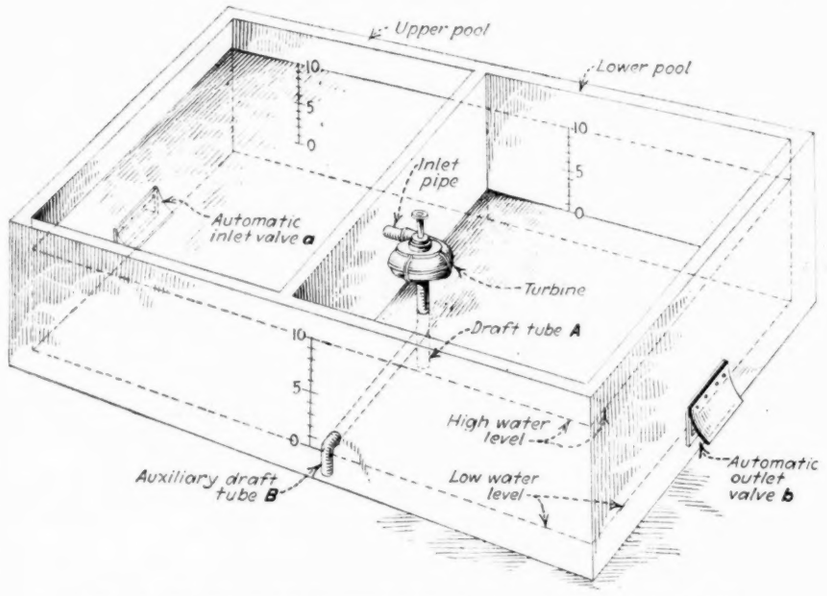


Fig. 1—Small model demonstrates continuous power production from rise and fall of tide

A small tide mill of this type has been used for sawing lumber at East Boothbay, Maine, for ninety-nine years (see *Power*, Sept. 19, 1922). The mill works at odd hours to suit the tide, power being generated by the outflow of water impounded in a pond at high tide.

For electric power generation, where intermittent supply is generally out of the question, the most practical arrangement involves the use of two adjacent reservoirs capable of interconnection and also of separate connection with the ocean. The juncture of two tidal rivers gives such a situation. A good example is the Hopewell project.[1] At Eastport the Passamaquoddy Bay

[1] See 1923 annual report of the Smithsonian Institution for analysis of the Hopewell project.

is capable of being cut up by dams into two large adjacent reservoirs, which in turn are cut off from the Bay of Fundy by other dams.

The method of operation of such a project to give continuous power can best be illustrated by a small model like that shown in Fig. 1. It should be explained that this model is designed to illustrate two-pool projects in general, rather than to the particular project at Eastport.

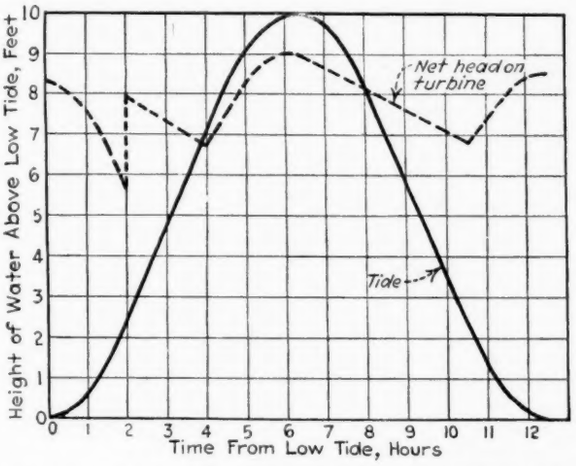


Fig. 2—Solid line shows rise and fall of a 10-ft. tide; dotted line gives net head for operation as shown in Fig. 3

For simplicity, this model is constructed for a tidal rise of 10 units, which may be assumed to be 10 in. in the model and 10 ft. in the actual ocean. The model is a box with two compartments each having a depth exceeding 10 units (say 15 units). The box is assumed to rest where it is surrounded by the tide, which rises and falls to the indicated levels. The left compartment is designated "upper pool" and the right "lower pool." On the upper pool is a flap (or check valve) *a* admitting water automatically whenever the ocean rises higher than the level within. A similar flap *b*, on the lower pool allows water to flow out whenever the level within exceeds that of the outer tide.

Now it is obvious that if this box is left undisturbed the upper pool will fill to level 10 on the first high tide and the lower pool empty to level 0 on the first low tide.

If water is now allowed to flow from the upper pool through the model turbine to the lower pool, power will be generated. This flow of water will gradually lower the level in the upper pool and raise it in the other, but if the pools are sufficiently large in comparison with the water consumption of the turbine, there will still remain a considerable difference of level up to the time when the water in the upper pool is replenished by the high tide or that in the lower pool is again drained by the low tide. The rise of water in the lower pool may be delayed somewhat by discharging the turbine directly to the ocean for the first hour or two after low tide. This increases the average head available.

One possible method of operation is indicated in Fig. 3. This is based on various assumptions that might never be met in practice, but gives an idea of how such problems may be attacked. It is assumed that the water flows through the turbine at a constant rate such as to lower or raise the level in one pool ¼ ft. per hour.

The turbine discharges to the ocean for the first two hours after low tide, after which it is switched to the lower pool. Thus, starting with low tide at midnight, the water level in the lower pool stays at zero until 2 a.m. Then it rises steadily to 2¼ ft. at 10:30 a.m. about 2¼ ft. Downpointing arrows represent the tailwater level and crosses the lower-pool level.

To study headwater and upper-pool conditions (which are identical) start at 6:15 a.m. At that time the tide is high and the pool filled to level 10. As the tide falls flap *a* closes, so that the falling level within is affected only by the flow of water through the turbine. At 12:30 p.m. the upper level will be 8.4 ft. As the diagram does not continue to the right, this level may be carried back to the previous low tide at midnight. From 8.4 ft. at midnight the fall continues to 7.4 ft. at 4 a.m., when the rising tide reaches the pool level and opens flap *a*. From there until high tide the upper-pool level is the same as the tide level.

The net head available at any time in the tide cycle may be obtained by measuring the distance between the upper and lower levels. This is plotted as the dotted line in Fig. 2.

It should be remembered that this cycle would be repeated every 12½ hours, making it an hour later each day.

In practice the demand for power would follow some irregular curve which would fall each day in a different relation to the tide curve, so the actual curve of net head could only approximate roughly that shown in Fig. 2.

On the whole the variations in power available from hour to hour and day to day would be much less serious than the seasonal flow variations in the average fresh-water plant.

In closing it should be re-emphasized that a decision regarding the feasibility of developing any particular tide-power project must involve not only the height of tides, conformation of land, cost of dam and power-plant construction, etc., but such matters as the size and nearness of power market, price of competing energy from coal and water power, etc.

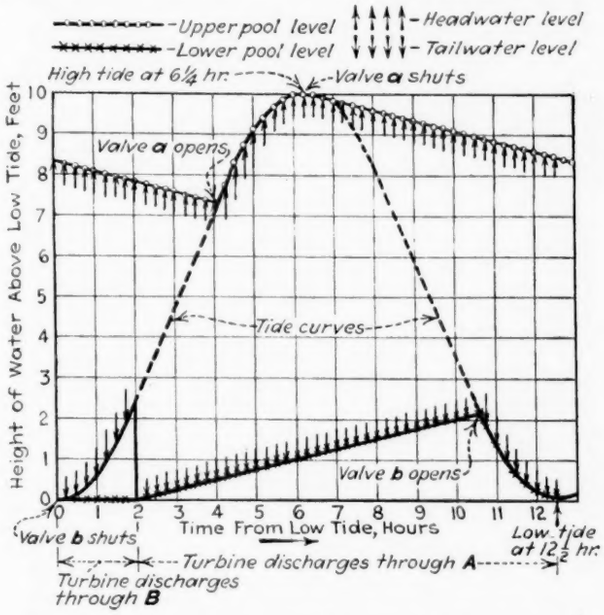


Fig. 3—Relation of upper and lower pool levels to the tide for assumed conditions

At this time the tide has fallen to 2¼ ft., so flap *b* opens and remains open until low tide. The level in pool *b* therefore falls with the tide from 2¼ ft. to zero between 10:30 a.m. and 12:30 p.m. The tailwater level of the turbine is the same as the level in the lower pool except from midnight until 2 a.m., when it rises with the tide to

Higher Steam Pressures and Temperatures

Steam at 400 Lb. and 700 Deg. now Conservative Practice—Plants Operating Satisfactorily at 550 Lb.—Results with Much Higher Pressures Soon To Be Available—Possibilities of Higher Temperatures Considered

THAT recent developments in the way of higher steam pressures and temperatures have been covered with reasonable thoroughness by the technical press is evident from the serial report, "Higher Steam Pressures and Temperatures," recently issued by the Prime Movers Committee of the N.E.L.A. This contains little in the way of facts or opinions not already more or less familiar to one who has followed what has been written on the subject. However, like all previous reports of the Prime Movers Committee, this is of great value because it gives a line on the present consensus of responsible opinion.

400 Lb. and 700 Deg. Conservative Practice

According to the report pressures up to 400 lb. and temperatures up to 700 deg. are now established as conservative practice for large stations. Satisfactory results are being reported from plants operating at 550 lb., and the results of operation of the 1,200-lb. plant at Weymouth are being awaited with interest. None of the large manufacturers or power producers seems willing at the present time to recommend steam temperatures beyond 750 deg. F., most of them feeling that normal operating temperatures should be limited to 700 deg. or 725 deg. at the most, until further advance has been made in developing suitable materials for higher temperatures. The possibility and even the probability of such development in the near future seems to be generally recognized, although the optimistic belief held by some that temperatures as high as 900 or 1,000 deg. F. may soon be commercially feasible, is by no means the universal opinion.

The following digest of the report is confined to points believed to be of special interest:

Little Trouble with High Pressures

The American Gas & Electric Co., referring to the operation of the Philo station for the first half of 1925 reports satisfactory maintenance of reheat temperatures during emergencies and the absence of material trouble with high-pressure piping or valves. The superheated and saturated pop valves on the boilers operated in a uniformly successful manner a great many times without supplemental leakage at the seats; in fact, the operation was fully as satisfactory as at lower pressures. The boilers, arranged for 650 lb. pressure and 750 deg. operated uniformly well. A few boiler superheater tubes failed, owing to temperature conditions in no way attributable to pressure.

According to the report of the Detroit Edison Co., less trouble than was expected has been experienced with the higher pressures and temperatures. There was practically no trouble with any of the high-pressure steam piping joints. Trouble was experienced with water columns, gage-glass fittings, trycocks and economizer relief valves, but experiments now under way promise relief from most of these difficulties.

In the design of the Richmond station the Philadelphia Electric Co. made a thorough preliminary investigation and study to determine the most suitable steam conditions. It being made apparent that 750 deg. was the safe limit with the materials available at this time, a maximum temperature of 700 deg. was selected as a working basis.

Richmond to Operate at 400 Lb. and 725 Deg.

The study indicated that a pressure of 350 lb. at the throttle, in combination with a heat-balance system employing three-stage bleeding and large air preheaters would result in the lowest total cost per kilowatt-hour. However, there was some question as to the reliability of boiler operation with the furnace air preheated to 650 deg. F. by the large preheaters assumed in these calculations. The final design of the Richmond station calls for boiler steam at 400 lb., with a maximum temperature of 725 deg. Economizers and air heaters will be used. The heat-balance cycle is arranged for three-stage bleeding in combination with all-electric auxiliary drive.

After a similar study made by the Union Gas & Electric Co. for their Miami Fort station, which is to operate on a base load, they determined upon turbine operation at 550 lb., 725 deg., with reheating.

A communication from the Edison Electric Illuminating Company of Boston explains the X-ray examination of steel castings as it was applied to the testing of turbine and other castings used for the 1,200-lb. installation at Weymouth. This method of testing, having already been described in the June 30 issue of *Power*, will not be discussed further here.

The most extensive single contribution in the report is a paper, "High Pressures or High Temperatures," by A. G. Christie and Douglas C. Turnbull, Jr., respectively professor of mechanical engineering and graduate student in mechanical engineering at Johns Hopkins University. This paper develops the thesis that more commercial gain is to be expected from increasing steam temperatures than from increasing pressures. The authors are confident that materials will soon be available to permit the practical realization of this gain. They emphasize the cost and expected operating difficulties of extreme high pressures. It is pointed out that, in the past, station economy has been improved by increased steam temperatures as well as by increased pressures, the present swing of attention to pressure being due to the fact that the practical temperature limit has been reached for the time being. Their study indicates considerable commercial gain if pressures around 400 lb. could be used with steam temperatures of 800, 900 or 1,000 deg. The authors point out that there would need to be no change in boiler design, while the decreased steam consumption would permit actual reduction in the size and cost of condensers and auxiliaries. Admitting the need of new materials for parts subjected to temperatures above 750 deg., they show that only a small portion of the plant would be subjected to these temperatures, chiefly the superheaters, steam piping and the high-pressure end of the turbine. Their conclusions are as follows:

"The curves indicate that for the Rankine cycle, the 400-lb. (absolute) plant with steam temperatures of 825 deg. or higher, is more efficient than even the 1,200-lb., 700-deg. plant on this cycle. The 400-lb., 1,000-deg. plant on the regenerative cycle equals the performance of the 1,200-lb., 700-deg. station. The curves indicate that the 600-lb., 700-deg. plant has the same performance as the 400-lb., 850-deg. plant. Steam temperatures of 850 deg. are said to have been used already in Europe on steam turbines."

Favors High Temperature and Moderate Pressure

"On the basis of these assumptions this study indicates that high plant efficiency may be obtained with high steam temperatures at moderate pressures. The gains compare so favorably with those obtained with plants using high pressures that further development of materials for high steam temperatures is fully warranted. It also seems probable that the use of such materials in a plant of moderate pressure will involve a smaller investment than would be needed for a high-pressure plant of equal economy, on account of the smaller amount of equipment that must be changed to use the high-temperature steam."

The paper made reference to recent experimental work on the strength of metals at high temperatures and particularly to the work of Prof. F. C. Lea of the University of Sheffield, England, presented December, 1924, before the Institution of Mechanical Engineers (Great Britain). The report includes an abstract of Professor Lea's paper.

A statement by the Babcock & Wilcox Co. makes mention of a number of boilers for 650 lb. working service with reheater units which have been installed. "The best pressure and temperature to adopt," they say, "can be determined only through actual service, and we are informed that data will be available in the near future on the actual results secured in such plants." Reference is made to the Weymouth 1,200-lb. boiler described in the April 15

and Sept. 15 issues of *Power*. This will be started up soon.

The General Electric Co. reports, in part, as follows: "Two General Electric turbines designed for steam conditions of 550 lb. gage and 725 deg. F. total temperature have been placed in successful commercial operation since the 1923-24 report was published. The first 40,000-kw. unit for these conditions, installed in the Philo station of the American Gas & Electric Co., was placed in commercial service Sept. 22, 1924. This unit was placed in commercial service with the promptness and smoothness now expected of large turbines designed for the more usual steam conditions. The 60,000-kw. cross-compound unit installed by the General Electric Co. in the Crawford Avenue Station of the Commonwealth Edison Company was placed in commercial service Nov. 14, 1924."

A statement from the Heine Boiler Co. tells of four 440-lb. boilers furnished during the year to the Tri-City's plant of the United Light & Power Co. at Iowana, Iowa. The steam is to be superheated to 700 deg.

Several pages are devoted to an abstract of a paper entitled "Recent Developments in the Use of High Pressure and Superheated Steam," by B. N. Broido, of the Superheater Co. An abstract of this article appeared in the March 3 issue of *Power*.

Relation of Pressure to Load Factor and Coal Price

Discussing Mr. Broido's paper, G. G. Bell, of the West Penn Power Co., says: "Probably the best study that has been made of the cost of producing power in high-pressure plants is that presented by Professors Hirshfeld and Ellenwood before the A.S.M.E. in December, 1923. The writer has prepared three diagrams showing the effect of the increased station cost and the better economy on the annual charges for capital and for coal, for plants operating at load factors of 40, 50, 60, 70 and 80 per cent, with coal at $3, $6 and $9 per ton. These costs do not include increase in maintenance for the higher pressures nor increased operating expenses, but allowance has been made that all costs in excess of $100 per kw. shall bear annual interest at a rate of 23 per cent in place of 13 per cent, which is used for the first $100. This increasing figure will, to a certain extent, take care of the difficulties resulting from the higher pressures.

"This study indicates that with $3 coal at a low load factor, the economical pressure is about 340 lb., whether the station is designed for reheating or the regenerative cycle; whereas, for load factors as high as 80 per cent the economical steam pressure would increase to 410 lb. for the reheating cycle and 440 lb. for the regenerative cycle. This is based on the assumption that the feed water is heated to the temperature of the saturated steam, by steam extracted from the main unit. As the cost of coal increases, the advantages of the higher pressure increase; so for $9 coal with 40 per cent load factor, 450 lb. is the economical limit; whereas for a load factor of 80 per cent, 500 lb. is the economical limit for the reheating cycle. For the regenerative cycle operated at 40 per cent load factor, the economical pressure is 520 lb. At 80 per cent load factor the costs are nearly the same between 600 and 1,200 lb.

"Until further data are available from plants actually operating at higher pressures, it is not probable that any substantial change would be made in the plants that are being designed at the present time, except maybe to raise the maximum boiler pressure from 350 to 400 lb. or slightly higher, as this is the maximum pressure for which the type of boiler we are using at the present time can be designed. This increased strength of the boiler would allow further deterioration of it before the capacity and efficiency of the plant has to be reduced on account of corrosion.

"Increasing the superheat to the limit permissible will probably result in a larger return on the investment than increasing the pressure, as the gain due to the greater mechanical efficiency of the machine on account of the lower friction of the superheated vapor than that of the saturated vapor, overbalances the gain due to higher pressure."

The following statement is submitted by the Westinghouse Electric & Manufacturing Company:

"Turbines now operating or about to be installed for use with high-pressure steam should make the coming year one productive of operating data that will permit a more accurate appraisal of the economical advantages of steam pressures above 400 lb. per sq.in. than is possible at present. Indications point to substantial practical gains in economy from a gradual trend to higher pressures. Pressures of 300 to 400 lb. are considered by this company as within the range of established practice. Turbines operating on steam within this range of pressure and a total temperature around 700 deg. F. have given no trouble in any way assignable to steam conditions and have shown efficiency and economic advantages over turbines operating on lower steam pressures in agreement with calculated estimates. This company is prepared to build turbines for steam pressures as high as other power-station equipment will permit. In view of the present status of information on the influence of temperatures on operation, it recommends that the total temperature at the turbine throttle be limited to 700 or 750 deg. F."

Destructive Forces Produced in Circuit Breakers*

By George A. Burnham†

IN MAKING a comparison of the design features of oil circuit breakers, it is interesting to consider the destructive forces acting on the breaker parts such as the frame or top, tank, tank fastenings and insulators, which tend to destroy their co-operative relation, and then analyze the breaker design with these points in view. The figure shows the relation of parts in a breaker of ordinary construction. These destructive forces may be divided into three classes, mechanical, chemical and electromagnetic.

Under the heading of mechanical forces may be included the effect of internal pressures due to circuit interruption, which exert both horizontal and vertical stresses.

At the instant the arcing contacts part, an electric arc is sprung, which displaces the oil. The rate of expansion and volume of gas generated depends, to a large extent, on the energy to be interrupted, the speed of circuit interruption, cooling effect of the oil, and the quality of oil used as an insulating medium.

This sudden expansion of the arc or gas bubble below the oil line produces a "hammer effect" on the sides and bottom of the oil tanks, the periodicity of which is at least equal to the natural periodicity of the electric circuit.

In this phenomenon it is assumed that no explosion takes place, and it is the writer's opinion that the pressure wave is of such a shape that no part of the breaker except the tank is subjected to any great stress. These forces may be relatively great near the arc zone and may produce tank bulging in breakers having a high head of oil and relatively light tank construction. A "balanced head" of oil, that is, a tank design in which consideration is given the head of oil with reference to tank shape and thickness, will obviate any serious difficulty from this source of force at the point in question.

Cause of Explosions in Oil Circuit Breakers

Forces due to ignition of chemical combination of gases thrown off during circuit interruption, as mentioned, may be of great magnitude. Explosions, so called, may occur either below the oil line during circuit interruption or in the expansion chamber above the oil line during or after circuit interruption. They may occur in distinct sequence, one following another, or, practically simultaneously, in which case the result of the force may be tremendous.

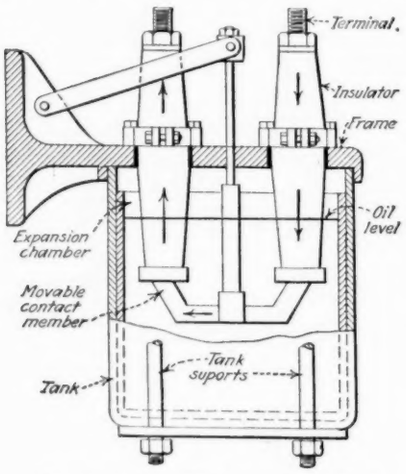
When the electric circuit is interrupted under abnormal conditions, the action of the electric arc on the oil and arcing contacts causes volatilization, and gases are thrown off. Some of these gases, and particularly certain combinations, if ignited by an electric arc or pressure, result in an explosion within the tank, the severity of which depends upon the volume of gas, kind of gas in combination, the proportion of combustible materials, and the shape of the pressure wave.

*Abstract from a paper, "The Selection and Maintenance of Oil Circuit Breakers," presented at the 20th Annual Convention of the Association of Iron and Steel Electrical Engineers," Philadelphia, Pa., Sept. 14 to 19, 1925.

†Engineering Department, Condit Electric Manufacturing Co.

These gas bubbles are given off in the oil at approximately the level of the stationary contacts or slightly below and are carried up through the oil to the expansion chamber at the top, owing to difference in the density of the gas and oil, or by upward pressure created by the arc disturbance.

If these gas bubbles are carried up through the oil in relatively small volumes entirely surrounded by oil, gases are chilled and reach the expansion chamber in a condition that will not tend to cause explosion. On the other hand, if the gas bubbles are extremely large or if the gas bubbles follow in close proximity so that the small bubbles interconnect to form a large bubble, there is a possibility of the electric arc communicating through this gaseous path with the mixed gases in



Cross-section of oil circuit breaker

the expansion chamber to produce explosion above the oil line.

Explosions below the oil line produce the so-called "piston effect" by forcing the oil in a body against the breaker top or frame. It may be of sufficient magnitude to cause the oil and gases to be forced from the breaker or may attain sufficient momentum to fracture breaker tops, insulator fastenings or breaker mechanisms.

Explosions above the oil line in the expansion chamber are, in the opinion of the writer, the major cause of broken switch tops, ruptured tank fastenings and tank deformation of a nature greater than the usual tank bulging.

The pressure per square inch may easily reach 300 lb., and therefore, in breakers with a tank diameter even as small as 20 in. the tank bolts and fastenings, tank and switch top must be capable of withstanding an impact of approximately 50 tons.

The construction of the average circuit breaker consists of a supporting frame or switch top, which carries two insulators per pole, and these insulators in turn support the studs to which the terminal wires are fastened at the air end of the insulator. At the lower end of the insulators a contact block is mounted and so arranged that a movable bridging member makes contact, thus completing the electric circuit, as in the figures. The path of the current in the studs is in parallel planes and at right angles to the plane through the bridging member, thus forming a U-shaped circuit. Such a condition causes electromagnetic stresses to be set up between the studs and certain reactions are set up in the bridging member due to the interlinking of the magnetic field of the component conducting parts.

These forces tend to loosen the insulators in the clamping rings, move the studs in the insulators, and force the bridging member from contact with the stationary contact blocks, even though the breaker be in a closed position. Little, if any, difficulty is experienced below 30,000 amperes, but at the high current values, say 80,000 to 100,000 amperes, the construction and bracing of the main current-carrying members must be extremely rugged to withstand these conditions, and the designer should use every effort to neutralize or balance these forces.

Inasmuch as the current that creates the magnetic field around the conductors is alternating, the resultant force is of the pulsating nature and of the same periodicity as the electric circuit.

Assuming that the average breaker requires one-tenth second from the time of short-circuit to the parting of contacts, it is apparent that on a 60-cycle circuit the conducting parts of the breaker are subjected to 12 pulsating blows, the severity of which varies as the square of the current.

From the foregoing it is apparent that when a circuit breaker functions under short-circuit conditions for a brief period of time, say, $\frac{1}{8}$ to $1\frac{1}{2}$ sec., depending on the relay setting, the main conducting parts may be subjected to pulsating forces, which vary from 12 to 180 strokes.

Combined Effect of Forces

During this time, also, the current has reached values many times the rated continuous current-carrying capacity of the circuit breaker, and as the heating varies with the square of the current, the temperature in the conductors reaches a very high value, bringing about expansion of parts, which, acting jointly with the electromagnetic forces, places a tremendous strain on the conducting parts; then at the moment of contact separation the explosive forces within the tanks bring the whole structure under tremendous momentary stress. In addition, during circuit interruption, the clearances under oil are reduced, owing to the expansion of the conducting arc gases which are in contact with the conducting parts. This has a tendency to cause flashover, sometimes resulting in the electric arc burning the tank lining or even burning a hole in the tank itself.

It appears almost unbelievable that a circuit-interrupting device could effectively disconnect 1,000,000 or 1,500,000 kva., under the foregoing conditions without destruction. With proper design, however, it is possible to interrupt the circuit under these conditions a reasonable number of times with practically no deterioration except of arcing contacts and oil.

The foregoing gives a sort of mental picture of the forces and factors tending to deteriorate the breaker during the circuit-interrupting period and in order that some fairly definite standard that might characterize satisfactory operation and good engineering be used as a basis of design and performance, the American Institute of Electrical Engineers and the Electric Power Club have adopted standards. The standards are for design and performance and are representative of what is considered a proper balance of good, sound engineering on one side and economical expenditure on the other.

Treating Acute CO Poisoning

The following steps in the effective treatment of CO poisoning are given in the Bureau of Mines Technical Paper 373[1].

1. The victim should be removed to fresh air as soon as possible.

2. If breathing has stopped, is weak and intermittent, or present in but occasional gasps, artificial respiration by the Schaefer method should be given persistently until normal breathing is resumed or until after the heart has stopped.

3. Pure oxygen, or a mixture of 5 per cent of CO_2 in O_2, should be administered, beginning as soon as possible and continuing for at least 20 minutes in mild cases and as long as 1 to 2 hours if necessary in severe cases if the patient does not regain consciousness.

4. Circulation should be aided by rubbing the limbs of the patient and keeping the body warm with blankets, hot-water bottles, hot bricks or other devices, care being taken that hot objects are wrapped or do not come in contact with the body and produce burns. This aids in tiding the body over a period of low vitality. Other stimulants, such as hypodermics of caffein, sodium benzoate or camphor in oil, should be administered only by a doctor after he has considered the possibility of collapse following excessive stimulation.

5. The patient should be kept at rest, lying down in order to avoid any strain on the heart; later he should be treated as a convalescent and given plenty of time to rest and recuperate.

6. After effects of CO poisoning should be symptomatically.

In conclusion, it should be emphasized that inhalations, for a period of 20 to 30 minutes, of oxygen or a 5 per cent mixture of CO_2 in O_2, if available, will, when given immediately, greatly lessen the number and severity of symptoms of CO poisoning, as well as decrease the possibility of serious after effects. All industries in which this type of poisoning is common should provide apparatus (inhalers) for the efficient administration of these treatments. This apparatus should be placed at points most convenient for treating CO poisoning, and employees should be trained in its use, so that resuscitation may be effected as soon as symptoms of poisoning are noted.

[1] "The Pyrotannic Acid Method for the Quantitative Determination of Carbon Monoxide in Blood and in Air" by R. R. Sayers and W. P. Yant. Sold by Supt. of Documents, Government Printing Office, Washington, D. C. 5 cents.

State Public Utility Commissioners' Authority Might Be Increased Greatly

Interstate Electric Service Could Be Controlled by State Authorities with Relegated Power from Federal Government

THAT the utilities commissioners of the various states see great possibilities of increasing the scope of their authority through the plan for Congress to make the state commissions a sort of federal agency, became very clear during the course of the thirty-seventh annual convention of the National Association of Railroad and Utilities Commissioners in Washington last week.

The idea of federal and state co-operation in regulation of utilities came up for discussion in connection with the proposed motor bus bill. That bill provides that Congress shall confer its federal powers and jurisdiction upon the individual state commissions, making each commission, within its state, a federal agency and thereby making it possible for the state commissions to exercise federal powers, as well as that conferred by the state.

It was very apparent that the commissioners see the possibility of applying this idea to interstate electric service. If made a federal agent by Congress, the state commission, many think, should have no trouble in doing what Secretary Hoover recommended—controlling interstate traffic in electricity by fixing prices at which the product could be sold. Without such a grant from Congress doubt was expressed whether such an act by a state commission would be held by the court as interference with interstate commerce. Such a grant of federal power to each state, it was emphasized, would require the right of appeal to the Interstate Commerce Commission when the states concerned could not agree. It was predicted that with the right of such an appeal the states rarely would fail to handle the situation and the number of appeals to the Interstate Commerce Commission will be few. Many of the commissioners seem to think that this plan offers the best means of co-ordinating state and federal powers and reconciling the principle of federal organization with local responsibility.

Despite the fact that the situation precipitated by the growth of motor transportation was the matter in which the majority had a very keen interest, fully 75 per cent of the time was devoted to the problems of steam transportation. The readjustment of freight rates has brought great popular pressure on the commissions to secure their revision downward. In the case of the electric utilities there has not been the same dissatisfaction over rates, and as a result the commissions have heard less from the public in that connection. The resentment that the commissions feel because of the fact that the Interstate Commerce Commission is circumscribing powers, also is responsible for the large proportion of the time consumed in the discussion of railroad matters.

Museum of Engineering to Entertain Dr. von Miller

Dr. Oscar von Miller, founder and director of the Deutsches Museum, of Munich, Germany, which opened with national ceremonies on May 7 last, attended by representatives of all the other great national museums of Europe, will arrive in New York about the middle of November. It is the intention of the National Museum of Engineering and Industry, with headquarters in the Engineering Societies Building, 29 West 39th Street, New York, membership of which includes many of the leaders in science, engineering and industry of this country and which has in hand the development of a great National Museum on the Mall in Washington, D. C., similar to the great foreign national museums, to tender to Dr. von Miller a reception and banquet to be attended by their friends and others who realize the needs of this country for a similar institution, not only to preserve the records, models and other visual testimonials and mementos of the pioneers in science, engineering and industry who have brought this country from a small scattered populace of farmers to the greatest industrial nation in the world in the short space of one hundred and fifty years, but to serve as an adjunct to the educational system of the country.

Samuel Insull, president of the National Museum of Engineering and Industry, who has been in Europe during the summer visiting the museums, will return shortly, and under his direction, with the backing of the four national engineering societies (civil, mining, mechanical and electrical) and other national organizations represented on his Board of Trustees, will have charge of ceremonies.

Boiler Explosion Statistics

The best source of official information regarding boiler explosions should be the boiler-inspection departments of the various states and cities.

The National Association of Boiler and Pressure Vessel Inspectors, composed of chiefs of such departments, has appointed E. W. Farmer, Chief Inspector of the State of Rhode Island, as statistician and from the secretary's office of the association we have received copies of his reports for August and September.

August

Number of boiler explosions 6, with 3 in code states and 3 in non-code states and 1 accident in code state; 58 were killed, 57 of which were in code states, the other one in non-code state; total of 70 injured, 66 in code states, 4 in non-code states. Most of these were killed and injured in the explosions of a boiler on the "Mackinac" in Rhode Island waters.

One explosion of gas tank, in code state, 1 injured.

One accident to gas tank, in non-code state, 1 killed.

One accident to elevator in code state, 1 killed.

Two accidents to elevators in non-code state, 2 killed.

One accident to pressure vessel in non-code state, 1 killed.

Seven accidents to pressure vessels relating to refrigerating appliances in code state, 1 killed and 18 injured.

Two accidents to pressure vessels relating to refrigerating appliances in non-code state, 1 killed.

One accident to steam appliances in code state, 1 killed.

Two accidents to steam appliances in non-code states, 2 killed.

Three explosions to steam appliances in non-code state, no casualties, considerable damage.

September

One boiler explosion in non-code state, no casualties and very little damage.

Two pressure vessels explosions and 2 explosions to steam appliances in code state, 1 killed, 3 injured.

Three explosions in gas tanks, and 1 accident in code state, 1 killed and 22 injured.

One accident to gas tank in code state, 1 killed.

One accident to pressure vessel relating to refrigerating appliances in code state, 3 injured.

Six accidents to elevators all in code states, 2 killed and 7 injured.

One explosion in turbine in code state, 11 injured and considerable damage.

Muscle Shoals Commission Hopes for New Offers for Property

McKenzie Reminds That Provisions of Law Prescribe Use of Property for War and Fertilizers

THE PRESIDENT'S Muscle Shoals Commission has been led to believe that offers for the government's properties on the Tennessee River will be forthcoming from responsible interests. An announcement to this effect was made by chairman McKenzie on Oct. 20. He admitted having correspondence recently with those interested in the Hooker, White, Atterbury offer. A new offer from that interest, Chairman McKenzie thinks, would be substantially the same as that submitted at the last session of Congress, which proposed a form of partnership with the government.

Mr. McKenzie told the representatives of the press that he hopes a unanimous report can be sent to the President. While he did not express an opinion in connection with the direct questions as to whether or not there would be a minority report, it was apparent that he regards this as not unlikely. He said the drafting of the report had not begun and that the opportunities of reaching common ground had not been exhausted. He called attention to the fact that many persons have lost sight of the fact that existing law provides for the use of this plant for the fixing of nitrogen for use in explosives in time of war and in fertilizers in time of peace. Speaking for himself alone, Mr. McKenzie declared that he thinks an attempt should be made to carry out the provisions of the law which prescribe the use of the property for the benefit of agriculture. If private enterprise will not attempt it, he thinks the government should conduct such operations until it had been demonstrated that it could not be done profitably. The government acting as a pioneer, as in the case of barge line operations on the Mississippi and Warrior Rivers, might be able to point the way to profitable operation by private industry, which then could take over the fertilizer manufacture.

In leasing the properties, Mr. McKenzie believes it is absolutely necessary, in order to have some guarantee, to fix a minimum amount of production and the maximum amount of profit. Mr. McKenzie emphasized his personal opposition to any separation of power and fertilizer operations. He believes the project should be leased as a whole.

Mr. McKenzie pointed out that he favors the further development of the Tennessee River. He has been advised by engineers that Dam No. 2, standing alone, is a weak sister. He expressed satisfaction that the government had sold none of its land in the vicinity of the plant. Speculators of the Florida type, he said, have run up the price of land for miles around, until industry could not afford to use it. If it should be desirable to induce industries to locate at Muscle Shoals, the government through its land ownership could provide a site.

While the commission hopes to complete its report so as to lay it before the President Nov. 1, it is recognized that it may not be possible to conclude the report by that time. The President has asked that the report be submitted not later than November 15.

G. E. Investigators Send Out Questionnaire

In connection with its investigation of the General Electric Co. the Federal Trade Commission has sent out an extended questionnaire to the electrical industry as a whole. It is believed that the commission in doing this was actuated by the belief that it must know about the whole in order to learn about a part. This investigation now is going ahead rapidly.

Weymouth Station Named for Charles Leavitt Edgar

In honor of thirty-eight years of service of President Charles L. Edgar, of the Edison Electric Illuminating Co. of Boston, the board of directors has passed a resolution which orders that the new station in Weymouth be named the Charles Leavitt Edgar station and that this name be inscribed on the building, which is to be designated as "the Edgar station" in all official documents and publications.

Braddock Power Plant Started

Ground was officially broken recently for the new power plant of the United Electric Light Co. at Braddock, Pa., on the Monongahela River. The power station is being designed and constructed by the Day & Zimmermann Engineering & Construction Co., of Philadelphia, and the equipment will be purchased from the Westinghouse Electric & Manufacturing Co. The new station will cost $700,000 and will be put into service in June, 1926.

Railroads Reduce Coal Bill by Millions

Nearly $23,000,000 was saved by the Class I railroads on their fuel bill during the first seven months of this year compared with the first seven months of last year, according to official figures just made public by the Bureau of Statistics of the Interstate Commerce Commission.

The total cost of coal and fuel oil for the first seven months of this year was $188,403,445 as against $211,374,783 for the first seven months of last year. This saving of $22,971,338 resulted partly from a decrease in the price of coal and partly from economies effected by the railroad managements.

Wilson Dam Reservoir Now Has Full Head

A full head finally has been built up in the pool behind the Wilson Dam at Muscle Shoals. The permanent switchboard will have been completed to the point where two generators can be operated at once. This will make it possible to deliver 50,000 kw. of hydro power for the Southeast.

General Harry Taylor, the chief of engineers, has spent the past week at Muscle Shoals in conference with Major Fiske and Major Tyler on matters pertaining to the further development of the Tennessee. The opinion of the chief of engineers on this point is certain to be asked, it is believed, in connection with the report which will be made by the Muscle Shoals Commission.

Noted British Engineer Dies Suddenly

Captain H. Riall Sankey, widely known English authority on steam and internal-combustion engines and past president of the Institute of Mechanical Engineers, died suddenly on Oct. 3, at the age of 71. Matthew Phineas Henry Riall Sankey, to give his full name, was born at Nenagh Co., Tipperary, in 1853, and was educated in Switzerland and subsequently passed through Woolwich and Chatham, securing his commission in the Royal Engineers in 1873. He remained in the Army until 1889, when he joined the board of Willans & Robinson, Ltd. In 1904 he severed his connections with this firm to take up consulting work in London, latterly in partnership with his son. The firm specialized in heat engines of every description on which Captain Sankey was an acknowledged authority. In 1909 he joined the boards of the Marconi Wireless Telegraph Co., Ltd., and the Marconi International Marine Communication Co., Ltd., which positions he retained until his death. For many years he took a leading part in the Institute of Mechanical Engineers and the Institution of Civil Engineers and has been a contributor of many scientific papers, principally about steam and heat engines. He was the author of a book "The Energy Chart and Its Practical Application to Reciprocating Steam Engines." For a paper entitled "Governing of Steam Engines by Throttling and Variable Expansion," he was awarded a Willans Premium; for the paper "The Thermal Efficiency of Steam Engines," he was awarded a Telford Medal and a Telford Premium; and for the paper, "The Strength of Shafts, Subject to Small Forces Rhythmically Applied," he received the George Stephenson Medal. Recently, he served on international committees on Steam and Gas Research, Steam Nozzles Research Committee and Marine Oil Engines. He was chairman of the joint committee of the English professional societies which were at work on revisions and formulations of Test Codes for Power Apparatus, and of the Institution of Civil Engineers, Heat Engine and Boiler Trial Tabulation Committee he was also chairman. Captain Sankey was a valued member of many English technical societies and also of the A.S.M.E.

Niagara Falls Power Co.'s Diversion Increased

An amendment to the license of the Niagara Falls Power Co., which will allow it to increase by 225 cu.ft. per sec. the amount of water it is diverting from the Niagara River, has been authorized by the Federal Power Commission. The amendment, however, is conditioned upon the acceptance of the license recently authorized for the Newfane Mill Owners' Association for the diversion of water from the New York barge canal into Eighteen Mile Creek. One condition of the license is that the Niagara Falls Co. continue to measure the amount of water spilled into Eighteen Mile Creek below the locks at Lockport. Another condition, intended to guard against unauthorized diversions into Eighteen Mile Creek, requires that the 225 sec. ft. may be reduced from time to time by the amount which, in the opinion of the commission, the waters spilled into Eighteen Mile Creek exceed the reasonable requirements for the navigation of the canal. A third condition specifies that the license is not to be construed as excusing the Niagara Falls Power Co. from paying proper state charges.

Hearings on Girand License Develop Much Opposition

After two days of further hearings on the application of James B. Girand for rights of the Colorado River at Diamond Creek, the Federal Power Commission took the case under advisement. An immediate decision is not expected. Some think it may be a matter of weeks before the commission announces its conclusions.

Such uniform opposition to the granting of the Girand license came from all of the states in the Colorado River Basin that it is recognized that an unusual amount of political courage would be required to order the license issued. On the other hand the attorneys for Mr. Girand contended that their client had complied exactly with the water power act. Under those conditions, they argued, a license may not be withheld legally.

On the eve of the hearing the United States Geological Survey issued a report by E. C. LaRue, one of its engineers, recommending a dam that would flood out the proposed dam at Diamond Creek. Before the hearing was ended, the State of Arizona formally filed an application for federal rights covering such a project.

The representatives of Mr. Girand contended that the rights of all the states could be protected by including conditions in the license. It was argued that any protection granted by the Colorado River compact would thus be made to apply to his development. L. Ward Bannister, representing Colorado, declared that any such waivers could not bind the commission or the applicant and that they left the third parties to the agreement without recourse in law. He urged that no action be taken until the compact has been ratified by all of the states.

The representative of Governor Hunt, of Arizona, opposed any private development on the river in Arizona on the ground that the state is preparing to undertake it.

A Midwest Power Conference Announced

Engineers of the Middle Western States are to hold a Power Conference in Chicago from Jan. 26 to 28, which from the tentative program now in preparation, should develop into one of the most comprehensive and valuable meetings of the kind ever held in this section of the country. Six different associations are to participate: Group 5 of the American Society of Mechanical Engineers, the Great Lakes Division of the National Electric Light Association, the Chicago sections of the American Institute of Electrical Engineers and the American Institute of Mining Engineers, the National Safety Council and the Western Society of Engineers. From an aggregate membership running well into the thousands an exceptionally large attendance is anticipated, and there will be room for all, as the meeting place in the new American Exposition Palace is admirably adapted for the purpose. During the same week and in the same building, Chicago is to have its first power show, giving to the engineers of the Middle West opportunity to inspect the latest and best in the field as is now offered by the New York show to engineers principally in the eastern section of the country.

The conference will deal with the larger aspects of power generation by steam and water. At the opening session notable authorities in the engineering field will discuss the extent of America's natural power resources, the possibilities from hydraulic power and how to make the best use of our available power. Following there will be a symposium on economical power generation, covering briefly the modern trends such as high steam pressures, pulverized fuel with consideration of the unit system, the carbonization of coal, air preheating, the later developments in feed-water treatment, water-power plant developments and perhaps other subjects to round out this review.

Naturally, this symposium will apply chiefly to the larger and more progressive plants of the country where the new developments are initiated, but another session is to be devoted to economies in the smaller industrial plant in which equipment, layout and methods of operation will be considered.

Inspection trips will be arranged for those interested in some of Chicago's engineering attractions, and as a concluding feature of the conference there will be a banquet with prominent speakers to enlarge on the social aspects of power utilization.

The committee in charge of the plans consists of: Arthur L. Rice, editor of *Power Plant Engineering*, chairman; G. E. Pfisterer, secretary; Karl A. Auty and L. M. Gumm for the A.I.E.E.; W. Sykes and W. R. Wright for the A.I.M.E.; Tom Wilson and Alex D. Bailey for the A.S.M.E.; W. del Carr and R. F. Schuchardt for the N.E.L.A.; W. D. Keefer and J. T. Benash for the National Safety Council; Walter A. Shaw and E. S. Nethercut for the Western Society of Engineers.

Oil and Gas Power Week Prize Awarded

Lt. Commander E. E. Wilson, of the Bureau of Aeronautics, Navy Department, Washington, D. C., has been awarded a prize of one hundred dollars by the American Society of Mechanical Engineers for his paper on "Power Plants for the United States Navy Aircraft," which was printed in the October issue of *Mechanical Engineering*. This prize was an award for papers written in connection with Oil and Gas Power Week.

Boston Edison Company To Be Connected With New Merger

Edison Electric Illuminating Co. of Boston will participate in the new financing of the New England Co. regarding which *Power* announced in the Oct. 6 issue, page 548, that Stone & Webster, Power Corporation of New York and International Paper Co. would participate. The Edison company already has facilities and contracts for the exchange of current with companies belonging to the New England Co. system, and it is expected that as a result of the new financing, facilities for exchange of current on a much larger scale will be afforded.

Oil-Switching Locomotives for Long Island Railroad

The Long Island Railroad is obtaining for switching service in its Bushwick Terminal, Brooklyn, an oil-electric locomotive of 100 tons weight. Less than two years ago a similar locomotive of 60 tons weight was introduced by the Ingersoll-Rand, American Locomotive and the General Electric companies and demonstrated on various Eastern railroads.

The locomotive for the Long Island Railroad will differ not only in being larger, but also in having two oil-engine-driven generator sets to furnish power to the four direct-current, geared traction motors.

The engines, manufactured by the Ingersoll-Rand Co. are vertical units of the four-stroke-cycle type, having six cylinders 10 in. diameter and 12-in. stroke, and will develop 300 hp. at 600 r.p.m.

Direct connected to each oil-engine is a six pole, 600 r.p.m. direct-current, compound-wound, commutating pole, General Electric generator. A 4-pole, 60-volt generator is mounted on the same shaft as each main generator, and serves to excite the field windings of the main generators. A 32-volt storage battery is supplied for the exciter fields at low speeds. The main generators are differently compounded so that the voltage is approximately inversely proportional to the tractive effort.

There are four direct current, series motors of the single geared, box-frame, railway type, classified as GE-69-C. Each motor is supported on its axle by axle brackets and bearings, and by the motor nose on the truck transom. The gearing is selected to give maximum allowable locomotive speeds of 30 miles per hour.

Long Beach Plant To Add Another Unit

Work is to begin immediately on the installation of a 50,000-kw. unit at the Long Beach steam plant of the Southern California Edison Co. This new unit will conform in general style and plan to the two 35,000-kw. units which make up Long Beach steam plant No. 2, which was built in record time last year. An addition to the present structure is to be built for the new unit. The coming installation will comprise a G. E. single-cylinder-type turbine rated at 50,000 kw., 50 cycles, three-phase, 11,000 volts; seven Stirling-type Connelly boilers built to operate at 375 lb. pressure and at a temperature of 725 deg. F.; Westinghouse condensers and burners capable of burning either natural gas or fuel oil.

The estimated cost of the new work has been placed at approximately $6,000,000, and the completion date has been tentatively set as July, 1926. Stone & Webster, Inc., who designed and built Long Beach steam plant No. 2, have been engaged to lay out and construct the new addition.

Power Club Discusses Simplified Practice

Few industries have equalled the record of the electrical industry in promoting a uniformity which enables its various sections to give a maximum of service at a minimum cost, E. W. Ely, of the Division of Simplified Practice, United States Department of Commerce, told members of the Transformer Section of the Electric Power Club, meeting in Briarcliff Lodge, on Oct. 19. In the complete interchangeability of lamp bases and other bases, in the development of greater uniformity in voltages, and in a number of other directions this has been a notable achievement, and the man in the street seldom stops to realize what such developments mean for his comfort and convenience.

The Electric Power Club, through the development of a book of standard specifications covering a wide range of electrical equipment, Mr. Ely said, has taken a still further step for the promotion of the industry's welfare. But to bring to everyone in the industry a greater measure of benefits accruing from the use of standards calls for an intensive effort to secure the greatest possible adoption of such standards.

"In your book of Standards," Mr. Ely said, "you have provided certain standards for carbon brushes. Yet a survey indicates that in the automotive field alone there are more than 2,400 size variations in carbon commutator brushes. In other fields the variety is as great if not greater.

"Last month, manufacturers of carbon brushes held a meeting in New York, and indicated that they were anxious to go forward with some program to reduce this variation. Through a resolution adopted by that meeting, they indicated that the carbon brush standards developed by the Electric Power Club would be a fitting basis for such a simplification program, and they expressed a desire that the Electric Power Club should sponsor the development of such a program. The manufacturers are willing to co-operate and are in favor of saving effort and time through the use of the Power Club Standards in order that there should not be a duplication of work."

In closing, Mr. Ely urged the Electric Power Club to join in this movement, and he offered the fullest co-operation of the Division of Simplified Practice, not only in bringing together the manufacturers, representative users and the distributors, but in helping to broadcast any action that may develop from joint consideration of the proposal.

Export of Canadian Power Heatedly Discussed

At the annual meeting of the American Society of Civil Engineers, which was held at Montreal, Oct. 14-17, one of the principal subjects under discussion was the export of Canadian power. This discussion resulted from a paper read by Ira W. McConnell, vice-president of the Dwight P. Robinson Co., of New York City, "Some Economic Aspects of Hydro-Electric Development in Canada." H. G. Acres, formerly hydraulic engineer of the Hydro-Electric Power Commission of Ontario, started the discussion by saying that there were some questions that had gotten beyond the stage of argument and into the stage of conviction and he considered the export of power from Canada to be one of these. Others to take an active part in the discussion were, Julian C. Smith, F. A. Gaby, Norman R. Gibson, George A. Orrok and Francis C. Shenehon.

Niagara Falls Receding Rapidly

The Corps of Engineers is in position to report promptly on the character of work necessary to halt the recession of the crest of Niagara Falls, the Chief of Engineers states. It is General Taylor's conception that this work should be under the general direction of the Niagara Control Board. He will be glad to place the services of the district engineer at Buffalo at the disposal of that international body. So much study already has been given the problem that a formal survey would require only a short time.

Before anything can be done toward halting recession, an agreement must be ratified by Canada and the United States. After the agreement has been ratified, Congress will have to authorize the survey and appropriate for it. It then will be necessary to secure additional legislation for the construction of the project itself. The slowness with which international affairs move and the delays incident to the securing of legislation are such that more than 25 ft. of additional recession is not unlikely, it is thought, before the erosion can be retarded. The recent airplane survey of the brink shows that 55 ft. of recession has taken place since 1917. The rate of erosion is increasing progressively as the water is forced more and more into the gorge it is wearing.

Columbia Station To Be Opened Nov. 12

Arrangements have been made for the formal opening of the new Columbia power station, formerly called the Miami Fort station, on Nov. 12. Distinguished guests from New York City, Cincinnati, Dayton, Hamilton, Middletown, Covington, Newport, Huntington and Charleston are expected to attend the dedication and banquet which will follow at the Hotel Sinton, Cincinnati. The actual dedication ceremonies will include the formal turning on of steam to Turbine No. 1, the closing of a switch admitting energy from the station into the Columbia distribution system and a brief address by President Gossler, dedicating the station to the service of the public. The following Saturday and Sunday the station will be open to the general public.

Obituary

Thomas Franklin Manville, chairman of the board of Johns-Manville, Inc., died suddenly on Oct. 19 of heart disease in his apartment at the Plaza Hotel, New York City, at the age of 63. Mr. Mansville had extensive interests in the asbestos and the insulation fields, being connected with the Arizona Asbestos Association, the Canadian Johns-Manville, the Asbestos & Danville Railroad of Canada, Asbestos Shingle Co., and he was also a director of the Worthington Pump & Machinery Co. as well as a director of various banks. At the head of widespread interests Mr. Manville showed himself a business leader of the highest type and exerted a strong personal influence not only among members of his own organization, but with all that he came in contact with. He was personally popular and was greatly interested in widespread philanthropies. His two children, Thomas F., Jr., and Lorraine, his father, A. T. Manville, of Pleasantville, N. Y., and his brother, H. E. Manville, survive.

Business Notes

The Johns-Pratt Co., Hartford, Conn., has removed its New York City office from 41 East 42nd St. to 20 Vesey St., Room 610. This removal was made on October first.

The Foster Engineering Co., 109 Monroe St., Newark, N. J., announces that George H. Bauer, assistant manager of sales, has been appointed manager of the Chicago branch.

The Robert June Engineering Management Organization of Detroit, Mich., has acquired control of the Electric Flow Meter Co., Kansas City, Mo., formerly the Hyperbo-Electric Flow Meter Co., of Chicago, and will henceforth operate the business under its own management, with executive offices at 8835 Linwood Ave., Detroit, Mich. Robert June becomes president of the company, J. M. Naiman, formerly general manager, becomes vice-president, consulting and chief engineer, with Maj. W. W. Burden, of the Robert June organization, as treasurer.

The Lombard Governor Co., manufacturer of oil engines, Diesel systems, Ashland, Mass., announces changes in its New York office. W. Merton Rice, who has been representing the company, has resigned to take up new duties as managing director of the Henry Gielow Co., Inc., and Harry A. Smith, formerly New York representative of the Hooven, Owens, Rentschler Co., succeeds Mr. Rice and will retain the office at 39 Cortlandt St.

The Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., has recently promoted executives of the company: Edward D. Kilburn, vice-president and general manager of the Westinghouse International Company, has been named vice-president in charge of sales, still retaining his connection with the Westinghouse Electric International Co.; Walter S. Rugg, who has been general sales manager since 1922, has been made a vice-president and will have charge of the engineering activities; Richard B. Mellon, of Pittsburgh, was elected a director of the company, filling the vacancy caused by the death of William McConway; Vice-president H. D. Shute will retain his direction of the broad commercial activities of the company, including customer relationships; Vice-president H. P. Davis, formerly in charge of engineering and manufacturing as applying to the structural electrical portions of the company's business, will have direction over the entire manufacturing activities of the company.

Trade Catalogs

Meters—The Bailey Meter Co., 2015 East 46th St., Cleveland, Ohio. Bulletin No. 34 describes and pictures the fluid meters for steam, oil, brine and water, manufactured by this company. Information on the use of the orifice for measuring the flow of liquids and drawings, diagrams and charts as well as photographs are included.

Internal-Combustion Engines — The Sterling Engine Co., 1252 Niagara St., Buffalo, N. Y. A catalog describing the internal-combustion engines, commercial type, prime movers for pumps, air compressors and generators has recently been published by this company. Illustrations, charts and diagrams add to the interest of the descriptions.

Stokers — The Marion Machine, Foundry & Supply Co., Marion, Ind. "The Marion Line of Type 'K' Heavy-Duty Stokers" is the name of a new catalog recently issued by this company describing this new stoker. The catalog is well illustrated and contains a drawing showing a section through the stoker and furnace.

Waste Heat Recovery — The Edge Moor Iron Co., Edge Moor, Delaware. "Waste Heat Recovery at the Hawkeye Portland Cement Co. with the Edge Moor Waste Heat System," is the name of a recent trade publication issued by this company. The plant is well described and various photos of the installation are included.

Drives, Chain—The Morse Chain Co., Ithaca, N. Y. A series of catalogs has recently been issued by this company on "Large Power Drives," or Publication No. 24, "Directions for Installing and Operating Morse Chain Drives," or Publication No. 18, and "Small Power Drives," or Publication No. 16. They are all well illustrated and contain tables of data.

Coming Conventions

American Institute of Chemical Engineers—Dr. J. C. Olsen, Polytechnic Institute, Brooklyn, N. Y. Annual meeting at Sinton Hotel, Cincinnati, Ohio, Dec. 2-5.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Convention at Engineering Building, New York City, Feb. 8-12, 1926.

American Marine Exposition. Peter A. Senseng, 15 Park Row, New York City. Exposition to be held in the 212th Anti-Aircraft Armory, 62nd St. and Columbus Ave., New York City, Nov. 9-14.

American Society for Testing Materials. C. L. Warwick, 1315 Spruce St., Philadelphia, Pa. Group meeting at Hotel Cleveland, Cleveland, Ohio, Oct. 27-29.

American Refractories Institute. M. C. Booze, acting secretary, 2202 Oliver Bldg., Pittsburgh, Pa. Fall meeting at the Waldorf-Astoria Hotel, New York City, Oct. 29.

American Society of Mechanical Engineers—Calvin W. Rice, 29 West 39th St., New York City. Annual meeting at New York City, Nov. 30-Dec. 4.

American Society of Refrigerating Engineers, William H. Ross, 154 Nassau St., New York City. Annual meeting at New York City, Nov. 30-Dec. 2.

American Society of Safety Engineers. G. S. Wood, 29 West 39th St., New York City. Meeting at New York City, Nov. 18.

Association for the Advancement of Science. Burton E. Livingston, Smithsonian Institution, Washington, D. C. Annual meeting at Kansas City, Dec. 28, 1925, to Jan. 2, 1926.

Eastern Ice Manufacturers Association. W. H. Ross, 35 Warren St., New York City. Convention at Hotel Chelsea, Atlantic City, Nov. 23-25.

Master Boiler Makers Association. Harry D. Vought, 26 Cortlandt St., New York City. Annual convention at the Statler Hotel, Buffalo, N. Y., May 25-26.

Midwestern Engineering Exposition, Inc. George E. Pfisterer, 53 West Jackson Boulevard, Chicago, Ill., general manager. Exposition and power show to be held in Chicago, Jan. 26-30, 1926.

National Association of Practical Refrigerating Engineers, Edward H. Fox, 5707 West Lake St., Chicago, Ill. Sixteenth annual convention and educational exhibition at Statler Hotel, Detroit, Mich., Dec. 8-12.

National Electric Light Association. M. H. Aylesworth, 29 West 39th St., New York City. Forty-ninth convention and manufacturers' exhibition, at Atlantic City, Young's Million Dollar Pier, May 17-21.

National Exposition of Power & Mechanical Engineering. Fred W. Payne and C. F. Roth, Managers, Grand Central Palace, New York City. Exposition at Grand Central Palace, Nov. 30-Dec. 5.

National Marine Engineers Beneficial Association. George A. Grubb, 313 Machinists Bldg., Washington, D. C. Convention at Washington, D. C., Jan. 18.

Society of Naval Architects and Marine Engineers. Daniel H. Cox, 29 West 39th St., New York City. Convention at the Engineering Building, 29 West 39th St., New York City, Nov. 12-13.

Engines — The Rollins Engine Co., Nashua, N. H. The construction and the various parts of this engine are clearly described in Bulletin No. 25, which may be obtained from the company at the address given.

Fans—The American Blower Co., Detroit, Mich. Bulletin No. 6103 was issued by the company during September. It describes the American H. S. Fans of Single Inlet. Tables of speeds, dimensions, brake horsepower and air cu.ft. per min. are included.

Boilers—The George T. Ladd Co., First National Bank Bldg., Pittsburgh, Pa. Catalog No. 23 "Ladd Water-Tube Boilers," gives details of construction of the various types of boilers manufactured by them. Cross-section drawings of the boilers and photos add to the usefulness of the catalog.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; *mine run* except Pittsburgh gas slack:

Bituminous, Net Tons	Market Quoting	Oct. 19 1925
Pool 1	New York	$2.75@$3.00
Smokeless	Boston	1.88
Clearfield	Boston	1.75@ 2.15
Somerset	Boston	1.85@ 2.35
Kanawha	Columbus	1.55@ 1.85
Hocking	Columbus	1.50@ 1.85
Pittsburgh	Pittsburgh	2.00@ 2.10
Pittsburgh gas slack	Pittsburgh	1.50@ 1.60
Franklin, Ill.	Chicago	2.25@ 2.50
Central, Ill.	Chicago	2.00@ 2.25
Ind. 4th Vein	Chicago	2.25@ 2.50
West Ky.	Louisville	1.20@ 1.50
S. E. Ky.	Louisville	1.40@ 1.65
Big Seam	Birmingham	1.60@ 2.00
Anthracite, Gross Tons		
Buckwheat No. 1.	New York	$2.50@$2.60
Buckwheat No. 1.	Philadelphia	2.50@2.75
Birdseye	New York	1.60

FUEL OIL

New York—Oct. 22, light oil, tank-car lots; 28@34 deg. Baumé, 4¾c. per gal., 36@40 deg. 5c. per gal., f.o.b. Bayonne, N. J.

St. Louis—Oct. 13, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.80 per bbl.; 26@28 deg., $1.85 per bbl.; 28@30 deg., $1.90 per bbl.; 30@32 deg., $1.95 per bbl.; 32@36 deg., gas oil, 4.5c. per gal.; 38@40 deg., 6c. per gal.

Pittsburgh—Oct. 13, f.o.b. local refinery; 30@34 deg., fuel oil, 5¼c. per gal.; 36@40 deg., fuel oil, 5½c. per gal.

Dallas—Oct. 17, f.o.b. local refinery; 26@30 deg., $1.45 per bbl.

Philadelphia—Oct. 15, 27@30 deg., $2.15@$2.21 per bbl.; 18@22 deg., $1.848@$1.908; 13@19 deg., $1.575@$1.635 per bbl.

Boston—Oct. 19, tank-car lots, f.o.b. heavy oil, 12@14 deg. Baumé, 4¼c. per gal.; light oil, 28@32 deg. Baumé, 5¾c. per gal.

Cincinnati—Oct. 12, tank-car lots, f.o.b. local refinery, 24@26 deg., Baumé, 6¼c. per gal.; 26@30 deg., 6¼c. per gal.; 30@32 deg., 6½c. per gal.

Chicago—Oct. 6, tank-car lots, f.o.b. Oklahoma, freight to Chicago 92c. per bbl.; 24@26 deg., $1.10 per bbl.; 30@32 deg., $1.25.

New Plant Construction

Ala., Birmingham—Bankhead Hotel Co., Chicago, Ill., awarded contract for the construction of a 15-story hotel at 5th Ave. and 23rd St., including separate heating and lighting plants, here, to H. L. Stevens & Co., 30 North Michigan Ave., Chicago, Ill. Estimated cost $1,700,000.

Ala., Montgomery—Independent Ice Co., J. W. Hunter, 115 North Lawrence St., Secy., plans the construction of a new ice plant on Highland Ave. Estimated cost $200,000.

Calif., Los Angeles — Water & Power Comn., J. P. Vroman, Secy., will receive bids until Nov. 3 for a 250 hp., 3 ph., 50 cycle, 2,200 v., a.c. Diesel engine generating set with direct connected exciter.

Calif., Oakland—M. I. Diggs, 17th St. and Telegraph Ave., Archt., will soon receive bids for the construction of a 14 story office and stores building at 16th St. and Telegraph Ave. for Latham Square Corp., c/o architect. Estimated cost $1,000,000.

Calif., Oakland—Hillcrest Hospital Assn., c/o Reed & Corlett, Bank of Savings Bldg., Archts., is having plans prepared for the construction of an 8 story hospital on Vernon Heights. Estimated cost $500,000.

Calif., Oakland—J. K. Leaming, Ray Bldg., awarded general contract for the construction of a 10 story hotel at 19th and Franklin Sts. to A. Johnson, Call Bldg., San Francisco. Estimated cost $1,500,000.

Calif., Oakland—Yosemite Laundry Co., 4627 Grove St., awarded contract for the construction of a laundry and power plant at Adeline and 28th Sts. to H. J. Christensen, 505 17th St. $45,677.

Calif., San Francisco—Hunter, Dulin & Co., 256 Montgomery St., plans the construction of a 25 story office building at Sutter and Montgomery Sts. Estimated cost $5,000,000. Architect not selected.

Calif., San Francisco — H. Lesser, A. Aronson, et al, 58 2nd St., are having plans prepared for the construction of a 10 story store and loft building on 4th St. Estimated cost $1,000,000. Ashley & Evers, Holbrook Bldg., are architects.

Calif., San Francisco—Russ Estate, c/o J. H. Rucker, Mills Bldg., is having preliminary plans prepared for the construction of a 25 story office building on Montgomery St. Estimated cost $1,500,000. G. W. Kalham, Sharon Bldg., is architect.

Calif., San Francisco—Syndicate, c/o C. E. Blanchard, 445 Miramar Ave., plans the construction of a hotel on Pacific ocean frontage. Estimated cost $1,500,000.

Calif., Santa Monica—Pacific Beach Hospital Corp., c/o W. H. Shaw, 1747 Maltman St., Los Angeles, Archt., is having preliminary plans prepared for the construction of a 7 story hospital. Estimated cost $750,000.

Fla., Gainesville—G. H. Cairns, City Manager, will receive bids until Oct. 28 for a 450-hp. boiler.

Ga., La Grange—Robert & Co., Bona-Allen Bldg., Atlanta, Engrs., plans electrification of the Calloway Mills, here; also the Elm City Cotton Mills. Hillside Cotton Mills and Unity Spring Mills will require approximately 3,000 hp. motors. Bids for electrical equipment will be called for later.

Ill., Chicago — Denford Building Corp., 105 West Monroe St., plans the construction of a 16 story office building on Clark St. Estimated cost $3,000,000. Architect not selected.

Ill., Chicago—H. Zisook, 1249 East 58th St., is having plans prepared for the construction of a 3 story apartment, store and office building at 75th St. and Exchange Ave. Estimated cost $500,000. T. R. Bishop, 35 South Dearborn St., is architect.

Ill., Greenville—City will soon receive bids for pumping equipment, distribution mains, etc., for waterworks system.

Ill., Kankakee—Federal Ice & Refrigerator Co., 142nd and Halsted St., Blue Island, awarded contract for the construction of an ice plant to Blome Sinek Co., 76 West Monroe St., Chicago. Estimated cost $300,000.

Ia., Cedar Rapids—First Avenue Realty Co., c/o W. K. Wisner, Waterhouse Blk., will receive bids about Nov. 3 for the construction of an 8 story hotel at First Ave. and North 2nd St., N. Hatton, 321 O.R.C. Bldg., is architect.

La., New Orleans—New Orleans Dock Board, is having plans prepared for port improvements, including the construction of a boiler plant, grain elevator and additional storage, bulk and commodity handling plant, etc. Estimated cost $50,000 and $300,000 respectively.

Me., Lewiston—Central Maine Power Co., is having preliminary plans prepared for the construction of a power house. Estimated cost $75,000. J. C. and J. H. Stevens, 187 Middle St., Portland, are architects. F. W. Mason, Waterville, is engineer.

Mass., Boston—Y. M. C. A., A. S. Johnson, Pres., 316 Huntington Ave., plans the construction of a hotel. Estimated cost $1,000,000. Architect not selected.

Mass., Cambridge (Boston P. O.)—E. N. Wyner, 18 Tremont St., Boston, plans the construction of a 10 story apartment at 1558 Massachusetts Ave., here. Estimated cost $500,000. Architect not selected.

Mass., Springfield — A. Freedman, 214 Belmont Ave., will soon receive bids for the construction of a 6 story hotel. J. W. Foster, 105 Bridge St., is architect.

Mich., Jackson—Hayes Hotel, awarded contract for the construction of a 9 story hotel to Christman Co., Porter Apartments, Lansing. Estimated cost $800,000.

Minn., Mankato — City has authorized $125,000 bonds for improvements to waterworks including pumping equipment, mains, etc. L. P. Wolff, 903 Globe Bldg., St. Paul, is engineer.

Miss., Cleveland — Mayor and Bd. of Aldermen, L. M. Guynes, Clk., will receive bids until Nov. 3 for furnishing and installing a 600 g.p.m. centrifugal ball bearing pump 125 ft. head, directly connected to a 30 hp., 3 ph., 2,200 v., 60 cycle, 1,600 r.p.m. ball bearing electric motor.

Miss., Gulfport—G. R. James, J. S. Savage, Memphis, Tenn. and J. A. Sykes, Gulfport, plan the construction of a 4 story warehouse and storage building including a cold storage plant on 29th St. here. Estimated cost $200,000. Architect not selected.

Miss., Louisville — Mayor and Bd. of Aldermen, will receive bids until Nov. 3 for the construction of a pumphouse and 500,000 gal. capacity reservoir. F. A. Livingston, is engineer.

Nev., Reno—Union Ice Co., 354 Pine St., San Francisco, Calif., plans the construction of an ice and cold storage plant. Estimated cost $200,000.

N. J., Camden — The Wilson Building Corp., 336 Market St., will soon award contract for the construction of a 12 story office building at Broadway and Cooper St. Estimated cost $600,000. L. B. Rothchild, 215 South Broad St., Philadelphia, Pa., is architect.

N. Y., New York—A. Bricken, 300 Madison Ave., is having plans prepared for the construction of an apartment at 810 5th Ave. Estimated cost $1,000,000. J. E. R. Carpenter, 598 Madison Ave., is architect and engineer.

N. Y., New York—I. S. Haynes, c/o H. C. Pelton, 151 West 42nd St., Archt., is having plans prepared for the construction of a 15 story apartment on Park Ave. Estimated cost $700,000.

N. Y., New York—Ice Service Co., S. Rubel, Pres., 68 Ninth Ave., is having plans prepared for the construction of an ice plant at 514 East 116th St. Estimated cost $100,000. E. M. Adelsohn, 350 Stone Ave., Brooklyn, is engineer. Owners will be in the market later for ice machinery.

N. Y., New York—Kenningway Corp., 250 Park Ave., awarded contract for the construction of an apartment at 62 East 79th St. to F. E. Rhoades Co., Inc., 342 Madison Ave. Estimated cost $500,000.

N. Y., New York—One Hundred Seventy Four Fifth Avenue Corp., S. Hoffman, Pres., c/o Schwartz & Gross, 347 5th Ave., Archts. and Engrs., is having plans prepared for the construction of a 15 story office and loft building.

N. Y., New York—Two Hundred West Seventeenth Street Corp., c/o G. A. Bagge & Sons, 157 East 44th St., Archts. and Engrs., is having plans prepared for the construction of a 9 story apartment at 241 West 17th St. Estimated cost $500,000.

N. Y., New York—G. A. Umvervagt, 15 Park Row, is in the market for a 350 hp., 3 ph., 60 cycle, 4150 v., 72 r.p.m., synchronous motor.

Okla., Haileyville—Southern Ice & Utilities Co., S. M. Marrs, Gen. Mgr., plans to remodel ice plant and install new machinery. Estimated cost $50,000. Private plans.

Okla., Seminole—M. B. Morgan, Wewoka, has been granted permit for the construction of a 25 ton ice plant. Estimated cost $40,000.

Pa., Philadelphia—Apartment Homes Inc., Stock Exchange Bldg., awarded contract for the construction of a 5 story apartment at 4111 Walnut St. to Robert E. Lamb Co., 843 North 19th St. Estimated cost $700,000.

Pa., Philadelphia—Arrow Can Co., 34 South 17th St., will build a 4 story apartment at Greene and Johnson Sts. by day labor. H. Pratt, 34 South 17th St., is architect. Estimated cost $750,000.

Pa., Philadelphia — Pennsylvania R.R. System, Broad St. Station, Philadelphia, plans the construction of a new produce yard including cold storage plant on a 41 acre site at Delaware, Vaudalia, Packer and Pattison Aves., South Philadelphia. A. C. Shand is chief engineer.

S. C., Glendale—D. E. Converse Co., has had plans prepared for the complete electrification of mill No. 1 Lockwood, Greene & Co., Healey Bldg., Atlanta, Ga., are engineers.

Tenn., Knoxville—City will soon receive bids for the construction of a new pumping station including a 15,000,000 gal. filter plant, etc. Estimated cost $1,500,000. Alvord, Burdick & Howson, 8 South Dearborn St., are architects.

Tex., Asherton—City plans an election to vote $35,000 bonds for the construction of an electric light plant. Engineer not selected. R. M. Taylor, Mgr.

Tex., Bastrop—Texas Power & Light Co., W. B. Head, 4841 Crutcher St., Dallas, Chn. Bd. of Directors, plans the construction of a 100,000 hp. power plant on the Colorado River here. Estimated cost approximately $8,000,000. Private plans.

Tex., Kingsville — Texas Central Power Co., Frost Bldg., San Antonio, awarded contract for the construction of a 30 ton ice plant here to Summer Sollitt Co., National Bank of Commerce Bldg., San Antonio, $40,000.

Va., Staunton — J. L. Witz Furniture Corp., has work under way on the construction of a new furniture factory including power house, etc. Lockwood, Greene & Co., 1 Pershing Sq., New York, N. Y., are engineers.

Wis., Milwaukee—Wisconsin Ice & Coal Co., 320 East North Ave., will receive bids about Oct. 26 for the construction of two 2 story ice manufacturing buildings at 500 31st St. and 37th Ave. and Orchard St. Estimated to cost $30,000 each. O. Luhr, 118 North La Salle St., Chicago, Ill., is engineer. Owner is in the market for 15 ton ice machines.

Wis., Racine—Alvord, Burdick & Howson, 8 South Dearborn St., Chicago, Ill., Engrs., are making preliminary investigations for municipal street lighting plant for city.

Que., Montreal—Guarantee Pure Mill Co. Ltd., 875 St. Catherine St. W., is in the market for complete equipment for cold storage plant on Rowen St.